DARWINIAN SOCIOLINGUISTICS:
Narratives as tools for investigating cultural transmission biases

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A dissertation submitted to the University of Bristol in accordance with the requirements for award of the degree of Doctor of Philosophy (PhD) in the Faculty of Arts

Department of Anthropology and Archaeology

April 2020

61468 words

Abstract

The extent to which humans rely on social learning is exceptional; it is central to our understanding of how culture evolves. Research into cultural transmission has shown that transmission itself is often biased: not all forms of information are transmitted or received equally. For example, we are more likely to remember information that pertains to social and survival domains (content), and more likely to retain information depending on the transmitter (context). Although there is evidence to support such strategies, there has been very little empirical study regarding how these biases concurrently act on transmission. Additionally, language itself might be a source of bias. In order to address these gaps, this thesis exploits the potential of narrative and storytelling to embody multiple social transmission biases. Storytelling also allows language to take a causal role in transmission. The introductory chapters summarise how the related fields of cultural evolution and sociolinguistics approach content and contextual information. Experiment 1 demonstrates a novel proxy for eliciting prestige bias, motivated by the need for a widely shared mechanism of establishing prestige information. Using sociolinguistic methods, we find that accents index differential prestige. The second experiment offers a fresh perspective on the oral transmission chain paradigm, bringing together locally calibrated linguistic indicators of prestige and various manipulated content biases. This study provides an ecologically valid experimental design with the potential for cross-cultural deployment. The third study is an innovative application of the *Family Problem Picture Task*, previously developed by sociolinguists to elicit vernacular speech. Participants individually order pictures to create narratives; then we explore the ways in which group dynamics can influence changes in narrative, and thus, biases in story content. The fourth study uses conversational data elicited by the *Family Problem Picture Task* to highlight the utility of the paradigm to investigate group dynamics and dominance. Together the four studies demonstrate the utility of drawing upon parallels that exist between sociolinguistics and cultural evolution, bridging the disciplines of linguistics and anthropology.

Acknowledgements and Dedication

Like storytelling, this thesis has been a collaborative process. This work could not have been completed without all the participants who took part in this research and speakers who lent their voices to this project; Rachel Sheer who provided wonderful stories (which we butchered); Russell Gray and the Max Planck Institute for the Science of Human History for funding; and the continued support and guidance from many people.

First and foremost, heartfelt thanks go to my supervisor, Fiona Jordan, for your advice and steadfast patience. Continuously you made the impossible seem possible and I am endlessly grateful for your investment in me. Beyond your expert guidance and limitless encouragement, one of your greatest strengths is your ability to build communities, which, in turn, also provided me with the best support network I could have asked for.

I have had the privilege to work with wonderful collaborators Ricky Berl and Mike Gavin from whom I have learnt so much. You have constantly challenged me intellectually, and to be a better researcher. I am so grateful to members (past and present) and friends of the excd.lab who have read multiple drafts, provided encouragement and intellectual stimulation, and (quite importantly) much cake. I must particularly thank Sean Roberts who has not only directly contributed to this research, but also shaped how I view the research process. Sincere thanks also go to Alice Mitchell, James Hawkey and Damien Mooney for being my linguistics primer over the years and providing so much mental relief throughout this labour of love.

Research has been a much more pleasurable experience thanks to all the others trapped in the tower and those a little further afield. Although there are too many to thank individually, I would particularly like to thank Sam Passmore, Francesca Migliaccio, Janet Howard, Caitlin Greenwood, Nader Zentuti, Pietro Carnelli, Jacob Wood, Tshari King, Lelia Wills, Jacob Pratt, Jessie Walker and Jack Moran for acting as sounding boards/programming helpers/therapists/light relief as needed.

Finally, thanks go to my family. Your support has been unwavering even when my career decisions have made no sense to you or when you thought my research was on kinship. You were the ones who first told me stories and fostered the love of learning that continues to drive me to this day.

For Thathi

Author's Declaration

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's Regulations and Code of Practice for Research Degree Programmes and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

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Table of Contents

List of Figures

List of Tables

List of Abbreviations

CCE	Cumulative cultural evolution
CE	Cultural evolution
CT	Cultural transmission
FPPT	Family problems picture task
IDEA	International dialects of English archive
MCI	Minimally counterintuitive
RP	Received pronunciation
SL	Sociolinguistics
WEIRD	Westernised, educated, industrialised, rich, and democratic

Chapter 1: Introduction

Imagine a small group of people, sharing stories around a campfire. In the morning these people disperse to forage, but after some time passes another campfire is lit. What of the original story survives? What is remembered and what is told again? What has changed and why do we remember what we do? Is it because of the speaker's language or is something about the story itself? What happens when there is more than one storyteller? Finally, why do some stories endure over time? The objective of this research was to demonstrate experimental methods from the fields of cultural evolution and sociolinguistics that can further our understanding of these big questions and explain why storytelling persists across cultures.

1.1 Cultural Evolution

Cultural evolution (CE) is the study of how cultural behaviours change over time. CE applies an evolutionary framework to human culture and draws upon parallels between culture and biology to develop theories that explain patterns of cultural variation and change. There has been much debate regarding the comparison between biological evolution and CE, ranging from the units of culture (Sperber 2000; Sterelny 2006b) to whether methods used to study biological evolution are appropriate for studying the cultural equivalent (Borgerhoff Mulder et al. 2006; Gray et al. 2007).

That culture may be subject to evolutionary processes is not a new idea. In *The Descent of Man*, Darwin (1871) suggested that evolutionary processes can be seen within aspects of culture including tool use, animal domestication and language. Some of the observations Darwin made, including the extent to which humans rely on culture in comparison to other animals, our dependence on social learning over instinct, and cumulative culture are still being debated. However, the formalisation of CE as a discipline came with the application of evolutionary biology models and methods to explain cultural processes and diversity (Cavalli-Sforza and Feldman, 1981; Boyd and Richerson, 1985). Over the last 40 years, CE studies have blossomed with research investigating topics including cultural diversity (Jordan

and Dunn, 2010; Kandler and Laland, 2009; Kirby et al., 2016; Mace, Holden and Shennan, 2005; Newson, Richerson and Boyd, 2007; Rzeszutek, Savage and Brown, 2012; Shennan, 2009; Sperber and Hirschfeld, 2004; Tehrani and Collard, 2009), transmission (Acerbi and Bentley, 2014; Aoki, Lehmann and Feldman, 2011; Borgerhoff Mulder, Nunn and Towner, 2006; Boyer, 1998; Eerkens and Lipo, 2007; El Mouden et al., 2014; Fogarty, Creanza and Feldman, 2013; Henrich, 2001; Hoppitt, Boogert and Laland, 2010; Jordan and Shennan, 2003; Laland, 1992; Mesoudi and Whiten, 2008; Mace and Jordan, 2011; Smith et al., 2008; Takahasi, 1998), and relationships with other forms of inheritance (Chudek et al., 2013; Durham, 1991; Laland, 2008).

The scope of this thesis is to investigate different factors that affect cultural transmission and how that in turn might affect the relative diversity of traits. By adopting a Darwinian approach, I acknowledge that traits are subject to cultural selection, comparable to natural selection (Mesoudi, 2011; Mesoudi, Whiten and Laland, 2004). Culture varies, is inherited, and variants are in competition for expression at a given time. As such we can explore this diversity in terms of inheritance and competition through transmission. The analogues between biological and cultural evolution are numerous. However, this does not imply that direct comparisons can be easily drawn. This chapter focuses on the ongoing debates within CE and how the discipline has been informed by biological theory. As a relatively young field, there are still gaps within CE theory to be addressed.

1.1.1. Culture

'Culture' has many different meanings ranging from the lay use of the word to the way different subfields of anthropology deploy the term. Culture has been used to describe the 'arts', shared practices (for example, 'drinking culture' or a 'culture of sharing'), and as a label to identify groups of people. The early social anthropologist Tylor described culture as "that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society" (1871 [2010], p.1). Although this particular definition is not used in current CE studies, many of the central tenets are preserved, including further exploration of how these factors are shared and acquired.

Within the field of CE it is widely accepted that culture is socially transmitted information (Flynn 2008; Griffiths et al. 2008; Laland 2008; Mesoudi 2011; Richerson and Boyd 2005; Tan and Fay 2011). In an overview summarising the state of the discipline, Mesoudi defines culture as "information that is acquired from other individuals via social transmission mechanisms" but also notes that many definitions of culture have accrued as the field of anthropology has developed (2011, 2). Although there is still disagreement over an explicit definition of culture and whether it is even a useful term (Lewens 2015), the changing definitions reflect that culture, like the discipline, evolves. For the purpose of this thesis I use the definition put forward by Mesoudi (2011) whereby culture is information transferred between individuals through social learning mechanisms.

Culture was historically described as a feature that distinguished humans from other animals. However, research increasingly shows that other animals are capable of behaviours that are deemed to be cultural such as tool use; it is therefore the *extent* of our capacity for culture that sets humans apart from other animals (Dean et al. 2014; Laland and Hoppitt 2003; Laland and Janik 2006). Culture has been used to explain a variety of phenomena including how humans have been able to colonise a variety of environments (Boyd et al. 2011; Ehn and Laland 2012), how different technologies are created and evolve (Shennan 2011), how social norms are created and reinforced (Falomir-Pichastor et al. 2013; Hornsey et al. 2003), and how humans developed language (Smith 2011; Smith and Kirby 2008; Steels 2011).

1.1.2 Cultural change

Like biological evolution, CE has equivalents for the processes by which culture evolves. Biological traits evolve primarily through mutation, drift or selection: a gene mutates creating a novel allele, which is transmitted to offspring either randomly or because it confers greater fitness to the individual. Culture also undergoes these processes (Cavalli-Sforza and Feldman, 1981; Boyd and Richerson, 1985), but the extent to which these mechanisms can explain the current state of the cultural landscape is not resolved. Ultimately, all three processes impact cultural change as innovations create variation and are spread through random copying (or drift) and biased transmission (or selection) (Reader, 2003).

Innovation is key to cultural change. Innovations can occur in multiple ways: through independent invention, copying errors, or modification of an existing variant (Kandler and Laland, 2009; Mesoudi, 2011). Analogous to biological mutation, it is through innovation that variation is introduced into the cultural repertoire (Mesoudi, 2011). Innovation is an optimal strategy in certain contexts. For example, we see that innovation increases with age and experience in instrumental learning of cultural technological tools (e.g. innovative manipulation of tools to reach a sticker reward in young children) (Legare and Nielsen, 2015), but is low in conventional learning such as ostracism behaviours (Watson-Jones et al., 2014). However, although innovations promote cultural diversity in the short term (Kandler and Laland, 2009), for any of these innovations to take hold in the population they need to be visible and spread either through drift, or advantageous and propagated via biased transmission (Mesoudi, 2011).

Cultural drift is the process by which the relative frequency of cultural variants changes due to random copying (Bentley, Hahn and Shennan, 2004; Mesoudi, 2011). Drift is often considered the neutral model (or null hypothesis for cultural transmission experiments) as any changes are due to chance. It has been suggested it is difficult to decouple neutral and selection model predictions, as variants may not be value-neutral but happen to be evolving neutrally, and vice versa (Bentley, Hahn and Shennan, 2004). Although variants may still be subject to bias, copying can still take place randomly, i.e. the bias is not evoked. An example of this is the popularity of baby names whereby names follow a power law distribution despite population growth (Bentley, Hahn and Shennan, 2004; Hahn and Bentley, 2003). Names that are deemed popular can be explained simply by frequency in the previous generation and random copying without having any intrinsic value. Even though it may seem as if particular names are favoured, the neutral model can explain this phenomenon.

Any deviations from the neutral model are usually attributed to selection pressures such as biased transmission (Mesoudi, 2011), through which innovations can diffuse. These biases influence our (often unconscious) choice to retain particular variants that have been socially transmitted over others. Here and throughout this thesis, I refer to 'choice' as the uptake or transmission of a particular variant over another without necessarily involving an active decision making

process. Biased transmission is considered analogous to selection as these variants are considered to be either most suited to a task (Fay, Garrod and Roberts, 2008), or have cultural fitness. Here, fitness does not necessarily mean biological fitness in terms of reproductive success, but the success of the variant being transmitted to the next generation (Heylighen and Chielens, 2009; Sterelny, 2006a; Strimling, Enquist and Eriksson, 2009). In Chapter 2, I review social transmission biases in detail; this thesis investigates the effect of biased transmission on the propagation (Chapter 5) and diversity (Chapter 6) of ideas through narratives.

1.2 Cultural Transmission

Cultural transmission (CT) is the process by which information is shared between members of a cultural group. As culture is shared, there is a consensus that cultural traits must be socially transmitted, whereby information and behaviour are transmitted from member to member within a population (Mesoudi 2011; Richerson and Boyd 2005). This section will focus on the ongoing debates regarding CT which are addressed by the research in this thesis.

1.2.1 Units of transmission

Memes, often likened to genes, have been put forward as units of information that can be transmitted by a process of replication or imitation (Blackmore 1998; Dawkins 1976). However, memes are deficient as a unit because there is no clear delineation of the scale of a meme. For example, in music, would a meme represent a song, a melody or even single notes? Furthermore, for memes to be successful they must be both 'sticky' and replicated exactly, yet transmission is rarely completely faithful.

Sperber and others classify information in terms of representations (1996; 2000; Sperber and Hirschfeld 1999; 2004; Claidière and Sperber 2007). This school of thought suggests that information can exist in mental representations as well as in physical manifestations of these mental representations (Sperber 1996). First language acquisition provides a demonstration of this idea: infants are able to copy movement patterns of the mouth and mimic the sounds of others (Kuhl 2004). This

behaviour is socially transmitted; physical representation (i.e. visual stimulus of movement patterns of the communicator's mouth and auditory stimulus of sounds) can be turned into mental representations and recreated without seeing all physical aspects of the sound's production (i.e. vocal cord movements). What 'information' itself is has been debated both in CE and biological evolution (Jablonka 2002); however, the term is still useful as it can be manipulated as necessary to explore different types of CT (Lewens 2015). Throughout this thesis, I use the definition put forward by Mesoudi where information is "knowledge, beliefs, attitudes, norms, preferences, and skills" (2011, p.3). Information can be acquired asocially or from other individuals.

Within CE research, the unit of transmission is contextually dependent and operationalised in different ways because the spectrum of information types present in the world is broad. Even within the same domain, there is variation in what is measured. For example, in storytelling, transmission might be measured by the successful recollection or stability of sentences or clauses (Eriksson and Coultas, 2012; Lyons and Kashima, 2006), propositions (Mesoudi, Whiten and Dunbar, 2006; Stubbersfield, Tehrani and Flynn, 2015), or motifs and events (Barrett and Nyhof, 2001; Bartlett, 1920; Bebbington et al., 2017; Stubbersfield and Tehrani, 2013). Other research pertains to the behaviours learnt (Colleran and Mace, 2015; Henrich and Broesch, 2011; Hewlett and Cavalli-Sforza, 1986; Lew-Levy et al., 2017). However, all of these units relate to information in some form whether directly or indirectly, which will be further explored in Chapter 2.

1.2.2 Modes of transmission

Unlike the biological transmission of genes, which is mainly vertical from parent to offspring, cultural information can be transmitted through vertical, horizontal and oblique channels theoretically with equal likelihood (Borgerhoff Mulder, Nunn and Towner, 2006; Cavalli-Sforza and Feldman, 1981; Gong, 2010; Mesoudi, 2011). *Vertical* transmission takes place when information is transmitted from parent to offspring. *Oblique* transmission is when information is transmitted from non-related members of a parental generation, and *horizontal* transmission refers to information

that is transmitted between peers (Mesoudi, 2011). Humans are also able to exploit multiple modes of transmission to learn variations of the same behaviours.

How we learn different types of information and from whom varies cross-culturally. These data are particularly difficult to collect but there has been a recent drive to collate comparable data (Lew-Levy et al., 2017). These modes are not fixed and vary throughout our lives. For example, Aka and Bofi hunter-gatherer children under the age of five years learn predominantly by vertical transmission, whereby approximately 80% of skills are learnt from parents (Hewlett et al., 2011). However, oblique and horizontal modes of transmission are more frequently adopted between the ages of 6 and 12 years (Hewlett et al., 2011; Lew-Levy et al., 2017). The composition of populations can greatly affect the modes by which information is transmitted, and the formalisation of education can result in higher rates of oblique and horizontal transmission due to exposure to a greater range of people. Children may also learn behaviours through child oblique and horizontal transmission modes via play (Lew-Levy et al., 2017; Pellegrini, Dupuis and Smith, 2007).

In addition to these modes of transmission, the scope of CT varies more than biological transmission, which can primarily be transmitted on a one to one basis in each transmission event. When we transmit information, we can do so both to individuals and groups, and we are also able to learn from multiple people. Even if we only express a single variant of a trait at a given time, we can hold multiple variants learnt from multiple cultural parents in our repertoire. For example, Enquist et al. suggest that we rely on multiple cultural parents for variants to attain cultural stability. Using mathematical modelling, they found that a uniparental model greatly restricted transmission and concluded that it is highly unlikely that we have relied upon single cultural parents to establish the variety of cultural traits that we demonstrate (Enquist et al., 2010). This is probably because not all information is correctly transmitted each time, and without accurate conveyance, traits are not likely to survive and reach cultural stability.

The transmission of stories demonstrates how beneficial multiple cultural parents can be. As stories are passed from generation to generation, information is invariably lost. Although individuals may re-innovate original material, once lost we are unable to regain original information through social learning. Eriksson and Coultas posit that information is more likely to survive multiple transmission events

if transmission is multiparental (2012). This is not just due to retention of information due to greater exposure. Using a transmission chain experiment over four generations, Eriksson and Coultas (2012) asked participants to listen to or read stories, and then asked participants to recall the story after 15 minutes. Three conditions tested exposure: 1) a single transmission condition (where participants heard or read a story once); 2) a double transmission condition (where participants heard or read the same story twice); and 3) a multiple parent condition (where participants heard or read two versions of the original story from the previous generation). As expected, the number of original sentences accurately recalled dropped across generations. However, across both written and oral mediums, by the fourth generation there were significantly more original sentences accurately recalled in the multiple cultural parent condition (followed by double, then single, transmission conditions). Even if some individuals do not transmit specific information, the likelihood of this information being retained in the population is greater. In earlier generations, Eriksson and Coultas found that the double transmission condition was more successful than the multiple parent condition (2012). However, an explanation for this might be that, as stories evolve over time and information gets lost, we depend on multiple cultural parents to fill in the gaps. Furthermore, where information is reiterated by multiple sources, we may deem this information more reliable, relevant and transmissible.

As the modes of CT are varied, how we make decisions about what to learn and transmit is complicated. The research in this thesis addresses aspects of the decision-making process, particularly whether we primarily rely on information that we infer ourselves, or from social learning. The *Family Problem Picture Task* (Chapter 6) explores how having multiple responses facilitated by stimulus enhancement can affect the decisions we make when negotiating what information should be transmitted. Each individual contributes a narrative, acting as a cultural parent, and we examine how decisions are made in the retention of original elements or innovation.

1.2.3 Potential mechanisms of transmission

Sterelny explores three mechanisms of CT, acknowledging the different positions various evolutionary theorists hold because it is unlikely that there is a single explanation that covers all cultural variation (2006a; b). Unlike natural selection which acts on the level of the individual, *cultural group selection* recognises that selection can occur on multiple levels where traits can confer benefits on a group (Boyd and Richerson, 2010; Henrich, 2004a; Richerson et al., 2014). Sterelny suggests that, driven by cultural group selection, cultural traits are likely to be transmitted vertically from parent to offspring with potential for oblique transmission if the information is available (2006b). He also argues we use *hybrid learning* (a combination of social learning and individual exploration), which has resulted in teaching as a by-product of niche construction. Again, cultural group selection is necessary, as niche construction is not the act of an individual and, therefore, parents cannot solely control the learning environment of their offspring. However, Sterelny (2006a) also suggests that memes have their place in transmission if we regard them as templates and not cultural replicators, to allow for imperfect replication, which can then be later improved upon. He states that *meme transmission* differs from his other theories of CE by placing the onus on the cultural trait being transmitted to be memorable and valuable (Sterelny, 2006a). All three mechanisms utilise social learning, which will be explained in greater detail in the next chapter.

1.2.4 Transmission fidelity

Whether or not we need high-fidelity CT to explain patterns of CE is a source of contention. High-fidelity transmission presumes that information must be transmitted accurately (Lewis and Laland, 2012); however, transmission is an imperfect process. Information is lost from generation to generation; yet, much of our cultural success is based on social learning, implying some degree of fidelity.

There are two schools of thought regarding whether fidelity is important for CT. The 'Paris' school of thought suggests that high-fidelity is unimportant as information is not replicated in transmission (Atran, 2001; Boyer, 1998; Morin,

2016a; Sperber, 1996, 2000). However, many cultural variants attain cultural stability. To explain this, it has been suggested that there are cognitive domains which are more attractive and, over successive generations, we transform this information to be closer to these attractors (Claidière and Sperber, 2007; Sperber, 1996; Sperber and Hirschfeld, 2004). As these cognitive domains are attractive, even if replication is not faithful, we converge on similar cultural information forms so that variants seemingly persist over time. For further explanation of the 'Attraction model', see Chapter 2, section 2.3.

Others suggest that some variants reach cultural stability not because the information itself is 'sticky' but due to other biases (Henrich and Boyd, 2002). For example, transmission errors are less important when there are large numbers of social learners as the variant is still likely to survive. In what Morin calls the 'wear and tear problem' of CT, he argues that this can be remedied by repeat transmission; quantity is more important than the quality of transmission (2016a). Additionally, if there are a large number of individuals displaying a trait, this trait can survive without perfect replication within a population through conformist transmission (Henrich and Boyd, 1998).

Many transmission chain experiments also show that transmission is influenced by biases (Barrett and Nyhof, 2001; Heath, Bell and Sternberg, 2001; Henrich and Henrich, 2010; Kashima, 2000; Mesoudi and Whiten, 2008; Mesoudi, Whiten and Dunbar, 2006; Stubbersfield, Tehrani and Flynn, 2015). These studies suggest that humans are not necessarily high-fidelity transmitters, however, we are more attuned to certain types of information, which we transmit more faithfully. This interpretation is not incompatible with a 'theory of attraction' but, here, information which corresponds with specific cognitive domains are considered more transmissible. This is more likely considering that many of these studies find that unbiased information is also transmitted alongside biased information.

However, some argue we are high-fidelity transmitters in many domains and this is an important aspect of cultural stability (Horner et al., 2006; Lewis and Laland, 2012). We see in studies with children that we are more inclined to 'overimitate' and faithfully copy irrelevant actions (Chudek, Baron and Birch, 2016; McGuigan, 2012; McGuigan and Graham, 2010; Nielsen and Tomaselli, 2010; Nielsen et al., 2014), supporting the notion that we are high-fidelity transmitters (Horner et

al., 2006). However, there is evidence to suggest that we are *efficient* imitators, rather than 'overimitators'. For example, Flynn (2008) used a diffusion chain method to investigate whether children were high-fidelity imitators. She found that children as young as 2 – 3 years old will faithfully use a demonstrated method to retrieve a reward from both transparent and opaque puzzle boxes and irrelevant actions were quickly dropped early in the chain (Flynn, 2008). This suggests that whilst we are faithful imitators, information still has to be relevant.

In a similar study with 4 – 6 year olds, Evans et al. found that children copy the majority of demonstrators when carrying out relevant actions to retrieve a sticker from a box (2018). This sticker could be accessed using a sweep or drawer mechanism and, when all demonstrators used the same retrieval action, children were more likely to copy the particular action they had seen. If all demonstrators also used irrelevant actions, these were also copied. However, in conditions where demonstrators varied in their use of relevant and irrelevant actions, children elected to copy actions demonstrated by the majority with the exception of when the majority of actions were irrelevant. Here, children would initially copy irrelevant actions but phased them out over subsequent trials, suggesting that children were also learning from their personal experience. A further age effect was found to support this interpretation, whereby older children were faster to drop irrelevant actions. This suggests that people may initially rely on high-fidelity transmission in the absence of prior knowledge but rely upon multiple strategies to gather information in the first instance.

CT is an imperfect process and information is lost over generations. So what exactly do we mean by high-fidelity transmission? High-fidelity could be viewed coarsely as perfect transmission of all information. However, I suggest that humans employ a more nuanced form of faithful transmission whereby we are able to discern relevant information and transmit that with high-fidelity ensuring greater efficiency of CT. Our ability to transmit relevant information from a young age suggests that high-fidelity transmission is an important component of human CE (Lewis and Laland, 2012; Tomasello, Kruger and Ratner, 1993; Boyd and Richerson, 1996; Whiten et al., 2009; Dean et al., 2014; Heyes, 2016). We may also be able to utilise other strategies that do not require faithful transmission based on evolved cognitive domains. However, this body of research suggests that we are unlikely to

employ this strategy alone. High-fidelity CT has also been shown to be important for cumulative cultural evolution, which depends on social learning to accumulate advantageous modifications.

My contribution to this debate exploits a method by which we can test the effects of indirect and direct biases, which influence the likelihood of a particular variant being transmitted over another through contextual or inherent value respectively. The transmission task (Chapter 5) explores whether recall and transmission are affected more by information about those from whom we are learning or the information itself. If high-fidelity transmission is important, we might expect that unbiased information, or information that is biased based on the propagator to be faithfully transmitted. On the other hand, if information is passed on solely due to intrinsic qualities, high-fidelity information is unnecessary, and biased information should be preferentially transmitted. As this study is a single shot transmission event, this also provides an insight into the fidelity of transmission without incentive.

1.3 Cumulative Cultural Evolution

The extent to which humans employ culture sets us apart from other animals and often it is cumulative cultural evolution (CCE) that is cited as a human distinction (Dean et al., 2014; Laland and Hoppitt, 2003). CCE has been defined as an accumulation of modifications over time (Tomasello, 2000; Caldwell and Millen, 2008a; Dean et al., 2014) resulting in something that no single individual could create themselves (Boyd and Richerson, 1996; Mesoudi and Thornton, 2018). These accumulations are progressive, and modifications are increasingly beneficial. This effect, dubbed the 'ratchet' effect, suggests that CCE is unidirectional, and that reverting to a less advantageous state is unlikely (Caldwell and Millen, 2010; Dean et al., 2014; Ehn and Laland, 2012; Enquist, Ghirlanda and Eriksson, 2011; Mesoudi and Thornton, 2018; Tomasello, 2000). The ratchet effect is established as the advantageous modification is adopted over a non-modified trait across the population and becomes stable. The advantageous modification remains stable until the next ratcheting modification is adopted, resulting in the eventual loss of less

advantageous traits and therefore relatively little slippage back to a disadvantageous state (Tennie, Call and Tomasello, 2009).

CCE is dependent on high-fidelity CT. There is some evidence to suggest that corvids (Hunt and Gray, 2003), pigeons (Sasaki and Biro, 2017) and other primates (Boesch, 2003; Schofield et al., 2018) may exhibit some behaviours that are in line with CCE, or precursors to CCE. To delineate between human and non-human CCE, Mesoudi and Thornton (2018) put forward a set of core and extended criteria to be met for a behaviour to be considered the product of CCE. Drawing on previous definitions of CCE (Boyd and Richerson, 1996; Tomasello, 2000), core aspects include: 1) novel variation of a behaviour through asocial learning or copying errors; 2) transmission of this variant to other individuals via social learning; 3) some sort of benefit conferred by using this variant; and 4) repetition of the innovation and social learning process so improvements accrue (Mesoudi and Thornton, 2018). Social learning is essential in the propagation of these variants and it is only through social learning that we can build upon variants, creating this ratchet effect.

Human CCE is distinguished by meeting extended criteria. We utilise cumulative culture in different ways, enabling us to create technologies that help us adapt to and transform a variety of environments. Humans can use multiple different variants in sequence to improve performance for a shared outcome. We also can use a single variant as a starting point for different lineages (e.g. projectile weapons diverge in form, however, similarities between subsets demonstrate shared descent and patterns of change) or combine multiple variants to improve a different performance measure (Mesoudi and Thornton, 2018). Variants can also be multifunctional, and humans can repurpose variants that enhance one measure of performance if it can be advantageous for another use. For example, iron hinges that were originally used for cathedral and castle doors were repurposed for ship rudders (Boyd, Richerson and Henrich, 2013). The repurposing of variants is analogous to biological 'exaptations' where the function of a trait shifts (Gould and Vrba, 1982). Through CCE, our creation of technologies is prolific to the point that it carves out niches to be filled with other technologies (Mesoudi and Thornton, 2018). It is our creativity and plasticity that enables us to transform variants to our advantage in different ways and sets us apart from other animals.

Multiple laboratory experiments have been used to simulate CCE (Caldwell and Millen, 2008b, 2010; Kempe and Mesoudi, 2014; Kirby, Cornish and Smith, 2008; Mesoudi and Whiten, 2008; Miu et al., 2018). Transmission chain (or serial reproduction) experiments are ideal for testing the effects of CCE as they act as a microcosm of evolution. Bartlett (1920, 1932) employed serial reproduction to investigate what is remembered and how we transform narratives. As the output from one generation becomes the input for another, the experimental paradigm allows for innovations to occur through copying errors or asocial learning, for transmission via social learning, and gives opportunities for iterated learning. The iterated learning mechanism, by which learning takes place due to exposure to the behaviour of another individual who previously learned the behaviour from a second individual and so on (Kirby, Griffiths and Smith, 2014), has a positive effect on CCE (Beppu and Griffiths, 2009; Kalish, Griffiths and Lewandowsky, 2007). For example, it has been shown in experiments building spaghetti towers and paper planes that towers got taller and planes flew further over time (Caldwell and Millen, 2008b). Later generations were more successful when they were able to view earlier generations of participants' creations. Although I do not explicitly address CCE in this thesis, the research forms a body of work, which can be extended to investigate this process. Chapter 5 presents the first step of a transmission chain experiment determining the different ways social learning is deployed. Chapter 6 looks at the effect of iteration and the prominence of social learning when personally gathered information is available. As both innovation and social learning are prerequisites for CCE, this research can contribute to the CCE discussion by determining the relative importance of individual and group created material.

1.4 Linguistic factors

Language, society and the relationship between the two are the subject of both linguistic anthropology and sociolinguistics. Language itself affects behaviour and indexes information pertaining to society and an individual's place therein. Considering that the link between anthropology and linguistics is well established (Duranti, 1997; Hymes, 2000; Samarin, 2000), it is surprising that CE studies have broadly ignored this relevant and data-rich domain. While language is considered a

cultural behaviour, very few CE studies test the impact of components of language as a vector for conveying information itself.

This thesis' research is informed by previous evolutionary work, but also by sociolinguistic theory and methods. In particular, we look to variationist sociolinguistics, which uses quantitative approaches to study language change, creating a potentially productive opening for discussion between CE and sociolinguistic disciplines. Stemming from studies of regional dialects, social dialectology took form as it became clear that linguistic boundaries also corresponded to non-linguistic factors such as identity expression and membership of social groups; this social connection has fed into modern sociolinguistics (Meyerhoff 2011).

As the field of variationist sociolinguistics has developed, different methods have been favoured, and there have been shifts in focus regarding the significance of particular variables (Eckert 2012). These changes have been characterised by 'waves' of studies, each building upon the previous wave, aiming to ascribe social meaning to language change. The first wave is characterised by looking at broad categories and their effect on language variation, and as such, allows language to index contextual social information. The second wave is exemplified by a move to more ethnographic approaches and a shift in focus to speaker interaction. This allowed for a more nuanced exploration of social networks and communities of practice. The third and latest wave moved towards looking at stance and how language constructs social meaning through speaker agency and conscious choice (Eckert 2012). The data examined in this thesis are analysed using a 'first wave' perspective and allow us to explore how linguistic factors can be used to index contextual information (see Chapter 3).

1.5 Narratives

Storytelling is found across cultures (Smith et al., 2017; Sugiyama, 1996) and can be deployed for many purposes including advertising (Chang, 2009), fostering and reinforcing social norms (Smith et al., 2017), teaching (Piquemal, 2003) and entertainment (Dudukovic, Marsh and Tversky, 2004; Zipes, 2006). It is the vast range of behaviours impacted that establishes the importance of narratives as a tool

for information transmission. Many studies have shown that stories themselves endure over time (da Silva and Tehrani, 2016; Nunn and Reid, 2016; Tehrani, 2013a; Tehrani and d'Huy, 2017), which suggests that this is a fruitful domain for the study of cultural transmission.

Narrative links multiple bodies of literature from anthropology to education and literary theory. Opinions differ regarding what constitutes a narrative, determined by differences in structure, content and medium (Abbott, 2010; Bauman and Bauman, 1986; Brown, Gabriel and Gherardi, 2009; Greenhalgh and Hurwitz, 1999; Genter, 1976; Ochs, 1997; Rayfield, 1972; Scalise Sugiyama, 1996). Narrative encompasses many forms such as literary tales, oral sagas and anecdotes covering many different genres. Here, I define narrative as any representation of a series of events that is presented in a written or oral form.

In this thesis we investigate a subset of narrative, primarily focusing on the oral medium. This research contributes to a body of work investigating the types of information that can be transmitted through narratives (Chapters 5 and 6) and how narratives are constructed (Chapter 6). Why storytelling is so popular a tool remains unresolved. I argue that it is the flexibility of narratives in both construction and function that renders stories a useful tool in the transmission of information (Chapter 6). In the current climate where social and online media play a large part in how information is disseminated, the study of narratives, their construction and what information is retained is paramount to understanding how 'fake news' spreads and gains virality (Lazer et al., 2018). We can observe that false information is spread not based on evaluation of the accuracy of information given but due to the prestige associated with celebrity and the mass reach of news or social media outlets providing the information (Allcott and Gentzkow, 2017). We investigate the dual effects of prestige and content of information on retention in Chapter 5.

1.6 Thesis Overview

This research explores (a) the relative importance of biased and unbiased information and (b) how narratives can be deployed to investigate how humans use different social learning strategies available. There is much evidence to support the existence of multiple social transmission biases, however, it is common

for single biases to be tested without controls for other factors that may impact transmission (see Chapter 2). There has been little empirical study determining the relative effects of transmission biases, and this thesis aims to expand on this knowledge by demonstrating and testing a paradigm where multiple biases concurrently act upon transmission (see Chapter 5). Additionally, I draw parallels between variationist sociolinguistics and Darwinian CE (see Chapter 3), and use methods and theory from both of these disciplines to investigate how accent can be used as a cue for prestige in oral transmission (see Chapter 4). It is imperative that we understand the impact of oral transmission in CE as much of our evolutionary history will have relied upon the oral transmission of information. Literacy is a relatively recent phenomenon and is not shared cross-culturally, therefore, narratives are particularly useful to orally transmit information through language.

This chapter has focused on the role of CT in CE. The next chapter (Chapter 2) provides an overview of social learning and the transmission of information, and the social transmission biases which influence what is attended to and recalled. Whilst the majority of this thesis is driven by CE theory and of interest to those studying CE, Chapter 3 is a position piece aimed at sociolinguists. Chapter 3 aims to dispel misconceptions about previous applications of Darwinian theory to linguistics, and provides reasoning about how variationist sociolinguistics can be explained within a Darwinian framework. Together, these three chapters (Chapters 1–3) provide the contextual background in which the experimental research is grounded.

The next three chapters (Chapters 4–6) draws upon both CE and sociolinguistic methods to study how linguistic and cognitive factors influence the transmission of information. Chapter 4 provides a background to variationist sociolinguistics and accent-attitude studies, and details an online experiment we have carried out in the United Kingdom (UK) and United States of America (US) to determine different perceptions associated with regional and non-regional accents. Using results from Chapter 4, Chapter 5 details a single-shot transmission experiment investigating both the effects of content biases and accent-based prestige bias on the recall of creation stories. Chapter 6 introduces a novel application of the *Family Problem Picture Task* and demonstrates how adaptations of this protocol can be used to investigate how we navigate decisions in how we

construct and tell stories, and how this is done with knowledge of multiple cultural variants. Chapter 7 focuses on how information elicited from adaptations of the *Family Problem Picture Task* can be used to investigate prestige and dominance.

Although Chapters 4–7 have their own discussion sections, the final chapter (Chapter 8) draws together the themes emerging from the thesis. Here, I ground the interpretations of the data collected in terms of CE and sociolinguistic theory where applicable. Although all of these experiments are with participants based in the UK or the US (i.e. from Westernised, educated, industrialised, rich and democratic or 'WEIRD' countries (Henrich, Heine and Norenzayan, 2010a; b)), these experiments are designed to be adapted cross-culturally. In this chapter I discuss the future implications of this research and the importance of cross-cultural replication. Whilst the methods used in this thesis are well established, this research provides a novel integrative approach, and Chapter 8 asserts the parallels between CE and sociolinguistics and the benefits of interdisciplinary study.

Chapter 2: Social Learning and Transmission Biases

Humans are social animals and much of our success in colonising and adapting to different environments is due to cumulative cultural evolution (CCE), which is underpinned by the faithful transmission of information (Boyd, Richerson and Henrich, 2011b; Caldwell and Millen, 2008b; Dean et al., 2014; Lewis and Laland, 2012; Mesoudi, 2011; Mesoudi and Thornton, 2018). Cultural transmission (CT) is how information is passed from one individual to another and is, therefore, dependent on social learning. Social learning is the process by which an individual develops their own behavioural repertoire by observing another individual or the outcome of a behaviour demonstrated by other individuals (Galef, 2009). Social learning provides multiple mechanisms for behavioural variants to be propagated across generations so that innovations are retained and can be improved (Mesoudi and Thornton, 2018), and reach stability in a population. Social learning can be less costly than individual learning, the process by which an individual adapts their behaviour based on their own personal experience of exercising different behaviours, in stable environments, and, as there are often multiple variants of traits, we rely on social learning strategies to determine which variants to copy. The ability to socially learn and transmit information is, therefore, a cornerstone of cultural evolution (CE). There are many ways people acquire information through social learning such as imitation, emulation, overt teaching, and stimulus enhancement (Rendell et al., 2011; Galef, 2015), and so these mechanisms, as well as transmitting information, can be applied to learning behaviours. Since human traits and behaviours have myriad variants, we have multiple options in what we demonstrate or transmit at a given moment, and there are a number of different strategies that people exercise to navigate this variation, some of which will be explained in this chapter.

2.1. Social Learning Strategies

Individual learning is not always the most efficient learning strategy (Boyd, Richerson and Henrich, 2011b; Boyd and Richerson, 1996, 1985; Galef, 2009; Henrich and McElreath, 2003; Kameda and Nakanishi, 2002; Laland, 2004; Mesoudi,

2011). For example, if an individual is foraging, it is potentially dangerous to employ trial and error when trying novel foods. We may employ social learning strategies that are based on our knowledge state. In uncertain environments, individual information may be outdated and social learning more advantageous (Kendal et al., 2018). On the other hand, we also need to be able to assess whether socially learnt information is current (Galef, 2009). These strategies stipulate the conditions where it is advantageous for an individual to copy others (Heyes and Pearce, 2015).

In the CE literature, 'social transmission biases' (Boyd and Richerson, 1985) and 'social learning strategies' (Laland, 2004) have been used interchangeably with respect to human CT. The popularity of the term 'social learning strategies' is likely because the term encompasses non-human animal social learning as well (Galef, 2009; Heyes and Pearce, 2015; Kendal, Giraldeau and Laland, 2009; Kendal et al., 2018; Laland, 2004; Rendell et al., 2011). In this thesis, I use 'strategy' and 'bias' interchangeably but the research I present here is only based on humans.

Social learning strategies act on different types of information that people are attuned to. Depending on the context, we can deploy relevant social learning strategies (Kendal et al., 2018). These biases can be conscious (e.g. copying the behaviour of successful individuals to be successful in that particular domain) or unconscious (e.g. listening to music that arouses emotion). Social transmission biases can drive cultural change through selection of particular variants (see Chapter 1, section 1.1.2). Biased selection of cultural traits is analogous to biological natural selection (see Chapter 3, section 3.4).

Social transmission biases broadly divide into two categories: 'indirect' or context biases (strategies about who to copy); and 'direct' or content biases (what to copy) (Boyd and Richerson, 1985; Kendal et al., 2018; Richerson and Boyd, 2005). This chapter focuses on some of the social transmission biases that have been suggested as an explanation of the cultural variation observed in the world.

2.2 Context/Indirect Biases

A convenient schema for considering context biases is to categorise them as frequency-dependent or model-based. Frequency-dependent biases mean that a cultural feature is more or less likely to be learnt or transmitted because of its

relative frequency within the population. Model-based biases refer to the adoption of a cultural variant based on who displays said variant. Ultimately the two categories are inter-related as model-based biases can lead to higher frequency displays and vice versa.

2.2.1 Frequency-dependent biases

Frequency-dependent biases can be positive (conformist) or negative (anti-conformist), where conformity and anti-conformity result in selection of traits beyond random copying. Frequency-dependent biases can explain the relative frequency and turnover of variants in a population. For example, Bentley et al. (2007) found that 20th century pop albums had similar turnover rates in the charts as expected by simulating random copying. When a feature is more frequent in a population, there is a greater probability of individuals picking up that behaviour by chance, which can be seen in the popularity and distribution of American Kennel Club dog breeds (Herzog, Bentley and Hahn, 2004).

Conformity refers to actively favouring those behaviours (Mesoudi, 2011; Richerson and Boyd, 2005). Anti-conformity is when traits are actively selected based on their rarity or novelty in the population. Anti-conformity results in multiple variants of a trait being transmitted between generations at a population level, which can explain why multiple variants can remain stable within a population (Mesoudi and Lycett, 2009).

Asch's (1956) classic line length study suggests that people are more likely to conform even if it goes against their individual knowledge. Participants were asked to determine which of three lines matched the length of a line previous shown, where responses were given in front of a group. However, unknown to the participant, the experimental group was composed of confederates, all or the majority of which chose an incorrect response. Participants in experimental groups were significantly more likely to select an incorrect measurement compared to the control group, a finding that was attributed to a conformity effect (Asch, 1956). This experiment or versions of it has been repeated to determine whether participants rely upon conformist social learning or their own asocial experience, but this finding has not been consistently replicated (Bond and Smith, 1996;

Muthukrishna, Morgan and Henrich, 2016), and others have argued that the interpretation has been exaggerated (Friend, Rafferty and Bramel, 1990; Hodges and Geyer, 2006).

Frequency-dependent bias is particularly useful in novel environments; if a trait is prevalent in the population it is less likely to be dangerous. Conformity can promote avoidance behaviours when dangerous stimuli are present. This can be seen in non-human animals. For example, a guppy (*Poecilia reticulata*) when introduced to an artificial predator will take any escape route available unless exposed to demonstrator guppies who have been trained to take a particular escape route. In this case, the risk is removed as the route has been established as safe, therefore, guppies will preferentially take this route (Brown and Laland, 2002). Humans also avoid dangerous behaviours by creating cultural conventions, social norms and taboos. Lindström and Olsson (2015) determined that people are more likely to rely on social learning, copy behaviours of others and conform to cultural norms when threatened with punishment as others' behaviours can be monitored and evaluated with little risk to the observer.

2.2.2 Model-based biases

Model-based biases can provide a valuable route to social learning; however, as an individual will display a changing suite of cultural traits, not all traits displayed by one individual will be advantageous at all points in time. Models could be chosen for a variety of reasons such as prestige or age or whether they are familiar or in-group, or for trait-specific reasons such as success derived from exhibiting a particular behaviour (Kendal et al., 2018; Rendell et al., 2011). A range of studies has explored how we can use different types of information about the people we observe to make decisions about what traits to adopt.

2.2.2.1 Prestige bias

Prestige has been widely explored as a cue for learners to evaluate whether particular behaviours should be adopted (Acerbi and Tehrani, 2018; Atkisson, Mesoudi and O'Brien, 2012; Boyd and Richerson, 1985; Cheng and Tracy, 2014;

Chudek et al., 2012; Henrich and Gil-White, 2001; Henrich and McElreath, 2003; Jiménez and Mesoudi, 2019b; McElreath et al., 2008; McGuigan, 2013; Reyes-Garcia et al., 2008; Richerson and Boyd, 2005). However, the extent to which prestige is important is debated (Jiménez and Mesoudi, 2019b; McElreath et al., 2008). Prestige is highly correlated with status and is something that is conferred upon an individual by others. Unlike dominance, in which an individual plays an active role through inciting fear or coercion, prestige can be measured in deference (i.e. by respect given or through submission) on the part of others within a group (Henrich and Gil-White, 2001; Jiménez and Mesoudi, 2019b; Mesoudi, 2009a; Richerson and Boyd, 2005). Because prestige is established based on surveying the deference and attention of others, as well as advantageous behaviours, it can provide cues of success and, therefore, a good model to copy. However, as prestige is bestowed on a person as a whole (Boyd and Richerson, 1985; Mesoudi, 2011), unrelated behaviours that do not contribute to the prestige of a model may be copied even if they are non-adaptive. This is often seen in celebrity endorsements whereby celebrities who have established prestige based on a particular aspect of their lives drive revenue for business by endorsing unrelated products or services (Erdogan, 1999; Tehrani, 2013b). For example, Beyoncé drinking Pepsi is unlikely to have contributed to her success as a singer.

Even though one might use prestige to evaluate the success of a potential model, prestige does not necessarily correlate with success or knowledge. There is evidence to suggest, however, that prestige bias is more influential than success bias despite evidence of success-driven advantages. Atkisson et al. (2012) devised a computer-based experimental game exploring how prestige cues affect participants' likelihood to converge on a style of arrowhead. In this game 113 students from the University of Missouri took part in three seasons of 'hunts'. They were given the opportunity to build an arrowhead and then for each following hunt they had either the option to use the arrowhead they had built again or to modify their arrowhead based on individual learning or social learning. It was in the participants' interests to try to maximise their success in the hunts, as there was a financial incentive in line with their 'calorific earnings'. If participants chose to modify their arrowhead by individual learning this would incur a calorific cost, reflecting potential costs from trial and error learning, but there was no cost to use their previous arrowhead or to

learn socially. The data are consistent with other studies showing that attentional information and by extension prestige is a factor in model choice (Boyd and Richerson, 1985; Chudek et al., 2012; Mesoudi, 2011). Participants were likely to view and copy other models when it was suggested that there was greater environmental instability. Participants were more likely to choose those models who others had also examined in greater detail. Despite success information available, participants were just as likely to copy others based on prestige as success despite success bias having a direct effect on the likelihood of a greater reward (Atkisson et al., 2012).

This could also be interpreted as a matter of group dynamics. Atkisson et al. argue that in a novel environment it is better to tap into generations of cumulative cultural knowledge by socially learning from prestigious individuals because it is time consuming to observe the whole population and determine relative frequencies between variants, which is what would be needed for a frequency-dependent strategy (2012). A bias towards prestigious individuals and traits is a useful strategy as, in a truly novel environment, how do we measure success? As others actively seek out particular individuals, this acts as an indicator of esteem. Furthermore, as others will follow this strategy, this prestigious variant is also likely to be widely adopted therefore fulfilling criteria for frequency-dependency.

2.2.2.2 Similarity/Familiarity bias

We can also use similarity and familiarity to choose reliable exemplars on which to model behaviour. This may be because we expect the consequences of selecting a trait to be more relevant, or because we have greater exposure to observe and assess these models. We may also use our choice to display particular traits as an exhibition of self- and group- identity. This type of bias can be linked to more specific cues that index shared social domains such as kinship, social class and locality. This can be seen in how hunter-gatherer children across 33 cultures in Africa, Asia, Australia and Oceania, and the Americas learn subsistence skills such as tool-making, foraging and hunting through explicit teaching from their parents (Lew-Levy et al., 2017). Within these groups, infants learn basic skills from their parents over other adults due to the greater amount of time spent together and they

continue to learn more complex skills in adolescence. However, in early and middle childhood, horizontal transmission is more prevalent due to greater time spent in shared locality (Lew-Levy et al., 2017). Exposure to behaviour plays a large part in whether particular variants get adopted. Model-based behaviours will also have a frequency dependent aspect, as Lew-Levy and colleagues demonstrate, but CT studies have failed to address this explicitly.

However, ethnographic data demonstrate how multiple biases can influence adoption of behaviours. For example, Colleran and Mace (2015) investigated individual, social network and community effects on the uptake of artificial contraceptives (e.g. condoms, hormonal pill) over natural fertility control methods (e.g. withdrawal, fertile calendar) in 22 ethnically and religiously (Catholic) homogenous communities in rural Poland. Contraceptive usage data were collected from 1995 women through interviews, and, to measure social effects, data were collected on respondents' female kin, and up to five female social network partners. It was found that female kin and social networks had the primary effect on all contraception with the exception of mothers. However, there was also a secondary effect based on neighbours: if an individual has religious neighbours they were less likely to use artificial contraceptive methods independent of her own religiosity. Considering that contraceptive use is a behaviour connected to reproductive fitness, it would be expected that strong kinship relationships such as mother-daughter relationships would affect the adoption of particular practices. The influence of different types of social groups can be accessed through broader social networks, therefore, we can bring a transmission bias framework to bear on these findings. These results demonstrate effects driven by kinship but also locality bias. Women adopt practices based on what they see carried out by neighbours in their close vicinity. It may be beneficial to adopt similar practices to those around an individual to avoid social costs for demonstrating different or alienating behaviours. Here, social capital is indexed not just by the models but also by the behaviour itself. As such, we also need to consider what are the inherent properties of the information itself that might explain why one variant is expressed over another.

2.3 Content/Direct Biases

Two content related theories have been put forward to explain the distribution of particular kinds of cultural variants in populations: 1) content or (direct) biases (Barrett and Nyhof, 2001; Mesoudi, 2011; Mesoudi and Whiten, 2008; Richerson and Boyd, 2005; Stubbersfield, Tehrani and Flynn, 2015); and 2) cultural attractor theory (Claidière and Sperber, 2007; Scott-Phillips, Blancke and Heintz, 2018; Sperber, 1996; Sperber and Hirschfeld, 2004). Both theories are compatible but relate to different processes of cultural transmission (Acerbi and Mesoudi, 2015). As content biases work by replication (although the degree of fidelity is debated) and cultural attractors induce a transformation process, both are likely to be in effect.

People are susceptible to cognitive biases, whereby our cognition creates representations that deviate from rational judgement (Haselton, Nettle and Murray, 2015). Content biases act on individuals sampling all traits available to them and evaluating whether a trait is more efficient *or* concordant with cognitive biases the individual already holds (Acerbi and Mesoudi, 2015). Participants adopt particular traits over others, but this is not a conscious process. Unlike context biases, content biases act on the inherent properties of traits to prefer certain variants over others or no variant at all (Mesoudi, 2011). These properties are deemed more attractive usually by appealing to memorability or relevance to the parties transmitting and receiving information. Much work remains to be done on the specific psychological mechanisms underpinning these biases.

Sperber and others have put forward a model of 'attraction' (Claidière, Scott-Phillips and Sperber, 2014; Claidière and Sperber, 2007; Sperber, 1996; Sperber and Hirschfeld, 2004) to explain why some variants are more successful than others. This model can also be used to explain why variants reach stability at population level, and why some variants change and converge to be more similar. The attraction model suggests that there are cultural or cognitive attractors, which we are drawn to (see Figure 2.1). These attractors are representations that have been reproduced by either cognitive, physical or environmentally biasing factors to take a form that is shared in a population (Buskell, 2017; Sperber, 1996). If we were to imagine a landscape where more similar variants were closer to each other and cognitive attractors spread throughout, the attraction model would predict that those variants

close to the cultural attractor would be preferentially transmitted and remain stable in the populations. The variants that are further away from the attractor will either fall out of the landscape or change through transmission to be closer to the attractor, explaining why some variants may converge on similar forms. Where variants diverge, this might be explained by the presence of another cultural attractor, which draws the variant in a different direction.

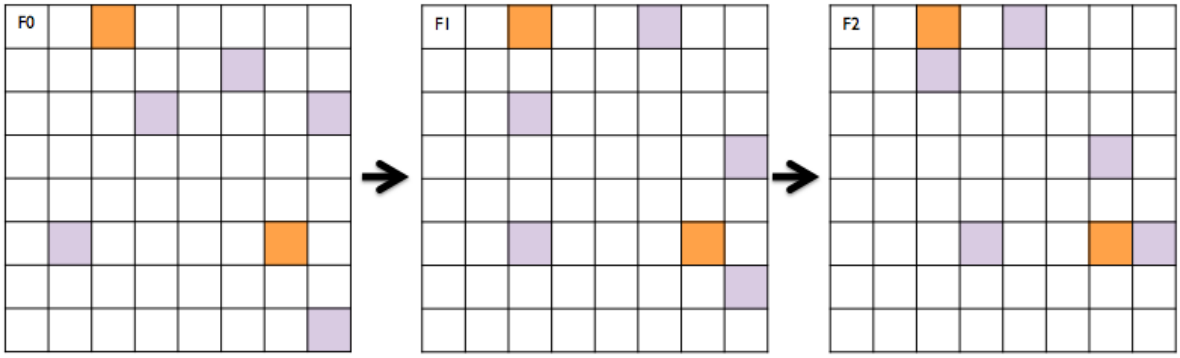


Figure 2.1. The Attraction Model. Orange squares are 'attractors'. Purple squares represent variants in a population. Over generations variants move toward attractors.

The main difference between content biases and cognitive 'attraction' is that the latter is transformative (Buskell, 2017). When information is transmitted it is not exactly reproduced. Adherents of cultural attractor concepts would describe the transmission process as a series of personal and public representations (Sperber, 1985, 1996; Sperber and Hirschfeld, 2004; Claidière and Sperber, 2007; Boyer and Ramble, 2001; Morin, 2016a; Scott-Phillips, Blancke and Heintz, 2018). On this model, an individual has a mental representation of the information in their mind and creates a public representation of this information to transmit. This public representation is not the same as the mental representation, and other individuals further transform this public representation upon receipt of this information and create their own mental representations of this information in turn (Sperber, 1996).

Cultural attractor theory does not require fidelity because (it is argued) variants should converge due to inherent attractive qualities of particular forms (Buskell, 2017; Scott-Phillips, Blancke and Heintz, 2018), and we can see these transformations in how errors (e.g. typos) are corrected. Content biases still require some level of fidelity but, unlike context biases, do not require high-fidelity

(Tamariz, 2019). Biases should influence selection and adoption of traits until a trait reaches stability in the population (Boyd and Richerson, 1985; Henrich, 2001; Mesoudi, 2011).

There are many different content biases, which may be at play in the cultural transmission process when attending to particular variants, and when choosing what information to transmit. The following sections provide an overview of some of the content biases that have been proposed and we evaluate their relative importance below.

2.3.1 Social bias

There is evidence to support a bias for social information (Mesoudi, Whiten and Dunbar, 2006; Stubbersfield, Tehrani and Flynn, 2015). Humans are social animals, and as content biases act on relevance to audiences, this is unsurprising. Dunbar (1998b, 2009) questioned whether primate brains developed to handle ecology-dependent problem-solving tasks or whether primate brains developed to deal with complex social systems (Byrne, 1996; Byrne and Whiten, 1988). Dunbar suggests that humans utilise 'theory of mind', the mechanism by which we hold false beliefs and 'mind-read' (Dunbar, 1998a; Kinderman, Dunbar and Bentall, 1998; Leslie, 1987; Tomasello, Kruger and Ratner, 1993; Vogeley et al., 2001; Wellman, Cross and Watson, 2001). Theory of mind can be found to some extent in non-human apes (Call and Tomasello, 2008), but humans are capable of computing higher order intentionality, which Dunbar takes as evidence to support the 'social brain' hypothesis (Byrne and Whiten, 1988). It is on this basis that we might expect a bias for social information.

If human intelligence evolved for the purpose of understanding complex social relationships and being able to cognitively compute the beliefs of others, we would expect people to be biased toward information that regards personal social relationships and social relationships between third parties. Mesoudi et al. (2006) investigated whether people are more likely to recall social information and gossip (or third party social information) than individual (information about a person where there is no social interaction) or physical information, such as information about geography and climate. In this experiment, Mesoudi et al. define 'social

information' as everyday, mundane interactions between third parties, and 'gossip' as intense social interactions between third parties. If there is a bias for social information we would expect the physical information to be the least faithfully recalled in comparison to the other conditions (see below) and variation between the other conditions based on the strength of the social information.

The study was based on the Bartlett method of serial reproduction whereby a narrative is given to a participant. What the participant recalls is passed onto another participant creating a chain of transmission (Bartlett, 1920, 1932). Mesoudi et al. (2006) used four participants in each chain simulating four generations of transmission. Transmission was quantified by coding the original story for propositions (Kintsch, 1974; Perrig and Kintsch, 1985; Turner and Greene, 1977) and counting how many of the original propositions are present in subsequent retellings. Across all four conditions information is lost over all transmission events, however, a greater proportion of gossip and social information is recalled for each generation. The rate of decay is similar across all conditions however in single generation transmission, gossip is best recalled, followed by social information and individual information as hypothesised (Mesoudi, Whiten and Dunbar, 2006). The results are consistent with the social brain hypotheses and suggest that social information is more likely to be recalled and with greater accuracy than non-social information. Subsequent studies with social biases have demonstrated similar results (Stubbersfield, Tehrani and Flynn, 2015; see section 2.4).

2.3.2 Survival bias

Survival biases pertain to ecological information that is relevant to survival (Stubbersfield, Tehrani and Flynn, 2015). Evolutionary psychology literature (Klein, Robertson and Delton, 2010; Klein et al., 2002; Tooby and Cosmides, 2015) suggests that memory evolved in response to selection pressures favouring goals that are fitness-oriented, and so, memory is functionally adapted to recall survival information (Kroneisen and Erdfelder, 2011; Nairne, 2005; Nairne et al., 2009; Nairne and Pandeirada, 2010; Weinstein, Bugg and Roediger, 2008). In studies where narratives related to survival are presented, these narratives are recalled to a greater extent than non-survival narratives (Nairne, Thompson and Pandeirada,

2007; Nairne, Pandeirada and Thompson, 2008). This is likely due to a fitness pay-off conveyed by selective retention of this type of information.

There are many studies investigating the effect of survival information processing on memory (Burns, Burns and Hwang, 2011; Kang, McDermott and Cohen, 2008; Kroneisen and Erdfelder, 2011; Nairne, Pandeirada and Thompson, 2008; Nairne, Thompson and Pandeirada, 2007; Nairne and Pandeirada, 2008, 2010; Olds, Lanska and Westerman, 2014; Otgaar and Smeets, 2010; Soderstrom and McCabe, 2011; Weinstein, Bugg and Roediger, 2008). The majority of studies above suggest that there are cognitive modules humans have evolved to solve issues in our evolutionary past such as avoiding predators and foraging food. However, some challenge the theory that our selective retention of survival information is based on ancestral priorities. Soderstrom and McCabe (2011) presented participants with one of five scenarios and asked participants to rate a list of 30 nouns for their efficacy in a survival context or for pleasantness in a control condition. The four scenarios presented as survival-based challenged ancestral priorities by including urban settings, attackers and zombies alongside grasslands and predators. Participants were asked to free recall the word lists and performed better in survival contexts than the control context. However, of the survival contexts, location did not affect recall success and lists associated with zombie scenarios had greater recall (Soderstrom and McCabe, 2011). This suggests that whilst we still favour survival information, our motivations to recall information have changed.

Furthermore, the richness of the text, and how information is depicted, may enhance memory for survival information (Kroneisen and Erdfelder, 2011). Kroneisen and Erdfelder devised an experiment where they varied the number of fitness-related features in the narrative so there would be fewer unique connections between the wordlist and the survival information. The original survival condition referred to predators and lack of food, whilst the modified survival condition referred to a lack of potable water. A scenario about moving to a different country was used as a control. Word list recall was greater for the original survival context compared to the control but there was little difference in recall for those who were exposed to both the modified survival context and the control scenario. Survival information did influence recall but greater encoding of survival information resulted in more accurate recollection. Similar results are found when a higher level

of threat is perceived in survival scenarios (Olds, Lanska and Westerman, 2014), suggesting that survival information processing is more effective based on intensity and relevance.

Whilst recall is higher in survival information conditions, so are false survival memories (Otgaar and Smeets, 2010). When provided with word lists associated with survival contexts, both adults and children remembered more terms accurately, but also falsely recalled information of related items that were not presented. Whereas biased information is successful due to memorability, this suggests that we are more likely to not only remember but transmit survival information even if specifically irrelevant because the broad domain of survival carries importance.

The utility of survival bias is undetermined. Although the studies above provide much evidence in support of survival bias influencing memorability, there is mixed support regarding relevance. Some experimental studies demonstrate underspecified selectivity (Otgaar and Smeets, 2010; Soderstrom and McCabe, 2011), whereas others suggest that relevance is crucial (Kroneisen and Erdfelder, 2011; Olds, Lanska and Westerman, 2014). Although Nairne and colleagues claim ancestral priorities as a reason why survival information is recalled over non-survival information, the literature suggests that this might be why humans are attuned to survival information, but not necessarily whether they select and transmit survival information. There has been one study which explores the effects of survival bias in conjunction with other biases (social), and survival had less of an impact (Stubbersfield et al., 2015; see section 2.4). Mesoudi et al.'s (2006) study of social information used a narrative depicting physical information that could also be considered ecological information that may have survival implications. However, this condition was the least recalled behind gossip, social and non-social information. Taken together these studies suggest that survival bias may influence the transmission of information but this has to be context specific when there is other more potential relevant information. In Chapter 5, we test the effect of survival bias whilst also accounting for other types of information.

2.3.3 Emotional bias

A number of evolutionary perspectives predict that humans may be particularly alert to negatively-valenced emotional information. Fear can be a response to ecological pressures such as predation, which can impact our survival (Boissy, 1995; LeDoux, 2012; Mineka and Öhman, 2002; Mobbs et al., 2015; Öhman and Mineka, 2001); disgust has been shown to effectively shape food aversions in response to potential plant toxins (Cashdan, 1998; Wertz and Wynn, 2014). It is imperative to remember information pertaining to survival and so these negative emotional responses have been shown to bias transmission (Bebbington et al., 2017; Heath, Bell and Sternberg, 2001; Jiménez, Stubbersfield and Tehrani, 2018; Stubbersfield, Tehrani and Flynn, 2017). Neuroimaging studies show that exposure to negative stimuli increases activity in amygdalar regions that correspond with memory processing for details (Kensinger, 2007; Kensinger, Garoff-Eaton and Schacter, 2007; Phelps, 2004), providing a potential mechanism for our effectiveness at remembering negative information.

Heath et al. demonstrate that disgust is a particularly attractive motif in the transmission of urban legends (2001). Participants rated a series of urban legends for arousal corresponding to basic emotions (i.e. anger, fear, disgust, sadness, happiness and surprise) as well as story characteristics such as believability and depth of characters to control for entertainment effects. Participants also had to indicate whether they would pass on this story in turn. The researchers found that stories that scored highly for disgust value were also more likely to be transmitted and, in further experiments varying the number of disgust motifs, stories that had more disgust elements were also more likely to be transmitted and were more widely distributed on urban legend websites (Heath, Bell and Sternberg, 2001).

Not only are people more likely to transmit negatively-valenced information but we also transform information to evoke greater negative arousal. Using a transmission chain paradigm, Bebbington et al. (2017) presented participants with stories including positively and negatively-valenced statements but also ambiguous statements which could be interpreted either positively or negatively. For example, the researchers include the statement: “Sarah saw a young man take an old woman's bag” (Bebbington et al., 2017, p.3), which could be interpreted either positively, as a

man helping an older woman with her bags, or negatively, as a man stealing her bag. Both positive and negative information were lost through successive generations; however, negatively-valenced information persisted for longer and was more likely to be recalled.

When ambiguous events were recalled and resolved, participants were more likely to construe events as negative and these negative resolutions were more frequent the further along the chain (Bebbington et al., 2017). Taken together, these experiments suggest that not only are people more attuned to negative information, but we are more likely to further perpetuate negative interpretations, strengthening the influence of this bias.

Emotional bias can also act more subtly on transmission. There is evidence to suggest that we ascribe emotional value to words (Bestgen, 1994; Kensinger and Corkin, 2003; Kensinger and Schacter, 2006; Stevenson, Mikels and James, 2007), which implies that these biases can influence any form of verbal or written communication. Individuals are consistent in their evaluations of lexical terms for emotional valence among other categories of semantic meaning (Bradley and Lang, 1998; Nielsen, 2011; Scott et al., 2018; Warriner, Kuperman and Brysbaert, 2013). We use these emotional judgments of words as the basis of an exploration of transmission of emotions in narrative and to assess whether there is a snowball effect of valence in subsequent story creation (Chapter 5).

2.3.4 Moral bias

While it has been suggested that there is a bias for moral information (Croson and Konow, 2009), this has not been explicitly tested in CT studies. However, moral information often is drawn upon as an explanation for the adoption of certain cultural behaviours suggesting that there is a capacity for a moral bias. For example, monotheistic Abrahamic religion has been suggested to influence the adoption of cooperative practices due to the presence of omniscient beings (Atkinson and Bourrat, 2011; Atkinson, Latham and Watts, 2015; Norenzayan, 2013, 2014). Here, religion provides a moral foundation that fosters cooperative behaviours both out of respect for moral entities and fear of punishment (Graham and Haidt, 2010). There is also evidence to suggest that other behaviours associated with religion such as

ritual human sacrifice can be used to foster and maintain stratified societies (Watts et al., 2016). Here we can see that religious behaviours can also be used to create communities and fortify social norms (Graham and Haidt, 2010). Although morality often pertains to religious information, it can be more broadly applied to societally accepted behaviours. Haidt defines moral systems as "interlocking sets of values, practices, institutions, and evolved psychological mechanisms that work together to suppress or regulate selfishness and make social life possible" (2008, p.70).

In the absence of a clearly defined moral or norm-based *bias* (Bicchieri and Chavez, 2010), we use the term throughout this thesis to mean any information pertaining to social norms and punishment for breaking these conventions, in line with Haidt's definition of moral systems. Social norms theory explains why some behaviours are adopted over others. Social norms delineate what is considered an acceptable behaviour within a group (Cialdini and Trost, 1998; O'Gorman, Wilson and Miller, 2008). According to this perspective, whether a behaviour is adopted is dependent on two factors: 1) the strength of the norm; and 2) the affinity the adopter has with the group holding the norm. The norms are reinforced and stabilise via shared acceptance and punishment (e.g. ostracism) for deviation from these norms (McDonald and Crandall, 2015). For example, people are able to assess inequality and make decisions in economic ultimatum games that promote equity (Bicchieri and Chavez, 2010). However, children demonstrate the importance of group affiliation in promoting social norms: they will allocate resources fairly to friends but not to strangers unless there is no cost to themselves (Moore, 2009). Bernhard and colleagues (2006) also found that people were also more likely to punish those not belonging to their social group (even at a cost to themselves) if they shared affiliation with a potential beneficiary of prosocial behaviour. Even though individuals are part of different groups and do not necessarily share social norms, norms are often projected and enforced on others.

Studies of social norms are not widely generalisable across humanity because of cultural constraints. The empirical research undertaken in this thesis is carried out with WEIRD participants (based in the UK and the US) and is representative of these populations only. However, all of the experiments can be adapted for cross-cultural study. Chapter 6 specifies an experiment (the *Family Problems Picture Task*) that has been designed for cross-cultural comparison. This is particularly important

when studying the effects of content biases because these biases are partially salient due to relevancy. Unless an experiment has been designed such that the biased content is relevant to the individuals, we cannot get an accurate measurement of whether a bias is effective.

2.3.5 Minimally Counterintuitive bias

Minimally counterintuitive (MCI) bias suggests that counterintuitive information is more likely to be transmitted over non-biased information. Counterintuitive information is information that defies intuitive principles in domains such as folk-biology, folk-physics and folk-psychology (Barrett, 2000, 2008; Boyer, 1994; Boyer and Ramble, 2001; Norenzayan and Atran, 2004; Norenzayan et al., 2006; Stubbersfield and Tehrani, 2013). For example, the concept of a werewolf violates folk-biology as our ontologically-driven understanding of our world does not allow humans to transform into other animals, ghosts violate folk-physics by being able to pass through physical barriers, and talking plants violate folk-psychology as, in our observable view of the world, plants do not have the capacity for speech. Within a content bias framework, we would not expect counterintuitive information to be transmitted because it does not contain information relevant to our environment.

However, although unexpected in terms of relevance, there is evidence to suggest that counterintuitive information is sufficiently memorable to be recalled in list form (Norenzayan et al., 2006). Participants were provided with eighteen terms (noun + descriptor) that were either intuitive (e.g. four-legged table, confused student) or counterintuitive (e.g. confused table, four-legged student). There were four conditions where the terms were either all intuitive or counterintuitive, or where 13 out of the 18 terms were intuitive or counterintuitive. When asked to recall the lists of terms after a three-minute delay, participants were more successful if terms were intuitive. Performance was poorer when the number of counterintuitive terms increased. However, when the task was repeated a week later, the participants in the MCI condition (13 intuitive terms) recalled more terms. Those in the MCI condition had the lowest memory degradation suggesting that MCI may have an effect on long-term memory.

To my knowledge, all studies that explicitly test counterintuitive biases on single generation transmission find some positive effect on retention. (Banerjee, Haque and Spelke, 2013; Barrett, 2008; Norenzayan et al., 2006; Purzycki, 2010; Purzycki and Willard, 2016; Stubbersfield and Tehrani, 2013). However, some studies found that this is tempered by relevance (Norenzayan et al., 2006), or that other factors were more influential (Purzycki, 2010). Purzycki found that counterintuitive information was more memorable than intuitive information but, when combined with humour, humour was a better predictor of recall. In fact, humorous plausible information was retained better than humorous counterintuitive information (Purzycki, 2010). This suggests that counterintuitive information is susceptible to modifiers, which can alter its influence both positively and negatively (see section 2.3.6). Furthermore, this suggests that there may be a hierarchy of factors influencing recall and counterintuitive information may be a secondary bias.

Although it is the counter-intuitiveness of the information that is more salient, these studies suggest that there is little support for counterintuitive information unless the number of counterintuitive elements is constrained (Banerjee, Haque and Spelke, 2013; Norenzayan et al., 2006; Purzycki and Willard, 2016; Stubbersfield and Tehrani, 2013; Upal et al., 2007). There is an optimal number of MCI elements that improves recall. Grimm's folktales were deemed to be culturally successful or not based on hits returned from a Google Search (Norenzayan et al., 2006). The top 21 and bottom 21 culturally successful folktales were coded for number of MCI elements they contained and the folktales that were deemed culturally successful had between two and three MCI elements. Recurring MCI elements do not affect recall; crucially it is the presence of a MCI element that affects transmission. Participants read six out of the 42 folktales and asked to rate them on characteristics such as memorability, ease of transmission and understandability. Across all three categories, folktales that were deemed MCI (containing between two and three counterintuitive elements) were rated significantly higher suggesting that this is a culturally attractive optimal (Norenzayan et al., 2006).

However, when narratives were told to children aged between seven and nine years, children performed significantly better in a comprehension and recall

task of narratives with one or two MCI elements compared to a completely intuitive narrative (Banerjee, Haque and Spelke, 2013). This effect disappeared when children were provided with stories with three intuitive violations suggesting that children have an optima of between one and two MCI elements. These results demonstrate a trade-off between memorability and relevance: in both adults and children, counterintuitive elements are retained because they capture attention and are memorable but the presence of too many counterintuitive elements can result in narratives becoming nonsensical. The difference in optima is minimal but suggests that there is likely to be variation at the individual level, and this too can change over a life course. As such, we must account for this in CT experiments and calibrate information for relevance to resolve whether any MCI bias effect is based on memorability, considering successful transmission is often measured by recall (Banerjee, Haque and Spelke, 2013; Bartlett, 1932; Boyer and Ramble, 2001; Mesoudi, Whiten and Dunbar, 2006; Nairne, Thompson and Pandeirada, 2007; Norenzayan et al., 2006). Why these optima should differ between children and adults is unclear; however, this may be because adults are better able to rationalise these counterintuitive elements and so can relate to a higher MCI optimum.

MCI bias can affect the transmission of information in multiple ways. Initially, MCI bias was put forward as an explanation of why religious concepts were so memorable, especially as in a religious narrative counterintuitive elements are often integral to the story and not problematic (Barrett, 2008; Boyer and Ramble, 2001). In addition to being memorable itself, MCI elements have been shown to improve recall of narratives as a whole (Stubbersfield and Tehrani, 2013). Stubbersfield and Tehrani used computational phylogenetic measures to determine relatedness between variants of the *Bloody Mary* urban legend and to analyse which traits had been preserved or transformed. Characters, or events within the stories, were identified as either intuitive or counterintuitive, with over 90% of story variations containing between one and three counterintuitive characters. Both counterintuitive and intuitive characters were stable throughout transmission suggesting that MCI element has an effect on related information (Stubbersfield and Tehrani, 2013). This might also be because MCI elements form an integral part of the story and may also be remembered because they are context dependent and often are used as explanatory device for unusual information in narratives (Upal et al., 2007).

In the next section, I examine the evidence for rational bias and its potential interplay with counterintuitive information.

2.3.6 Rational bias

A bias for rational or explanatory information is intuitive because explanatory information can be relevant itself as well as potentially influence the transmission and recall of other information types. In Bartlett's (1920) study of the serial reproduction of folk tales, he noted that participants were likely to insert words denoting causality, such as 'because', 'for' and 'therefore' in their retellings of stories, in what he deems "rationalisation proper" (1920, p.43). He provides some anecdotal evidence to suggest that explanatory information is retained and even added when information is reproduced and when representations are transformed. This is especially so when used in conjunction with counterintuitive information. Bartlett relates an example of a person who has been hit with an arrow but feels no pain. The injury without pain is counterintuitive but the original story rationalises this by suggesting that the person is a ghost who cannot feel pain. In subsequent transmission of the story, participants dropped this explanation, as it is itself counterintuitive, instead transforming the injury to a fatal wound, creating a rational consequence for this event (Bartlett, 1920).

Additionally, Bartlett (1920) provides another example where, in a different story, counterintuitive information is transformed. In the original story a boy transforms himself into a peanut kernel, however, in later retellings, the boy hides himself in an acorn kernel. Both of these events are counterintuitive so the bias is retained even if the information is not transmitted faithfully. This counterintuitive transformation is justified by providing a moral explanation: the son is repentant for hiding from his father and accepts punishment. In this case, the utility of rational bias has resulted in counterintuitive information being conserved and the addition of morally biased information, suggesting that social transmission biases work in tandem and affect one another.

In both scenarios, testing the direct effect of a rational bias is complex because it may not result in the rational information being transmitted but rather adjacent related information. Bartlett did not set out to test the effect of rational bias

but observed that individuals were transforming stories to include more rational behaviours. As far as I am aware, no contemporary CT experiment has explicitly tested for the effect of rational bias, and the examples above demonstrate some of the complexity associated with measuring this data. A bias for rational information could lead to the exclusion of information if the explanation is counterintuitive. Both examples demonstrate that although a rational bias may be preserved, it can be transformed in such a way that the content is lost and cannot be accounted for by recollection as a measure of transmission. The bias may not influence the memorability of information, but the bias itself is salient. This opens up many avenues of inquiry regarding the utility of transmission biases for the successful transmission of information. Here, the bias hinders recall but does signal the need for explanation and permits the receiver of information to adapt the content to be more relevant to their needs. To address these caveats we assess the retention of rationally biased information in Chapter 5, and in Chapter 6 I investigate how content, including rational information, is transformed over generations of storytelling.

2.4 Testing multiple transmission biases

Research on transmission biases varies in both scholarly influence and what studies have been replicated. Although the social information bias paper by Mesoudi and colleagues (2006) has been cited 244 times, this experiment has not been replicated. The only other study that explicitly tests for social information also tests for interactions with survival bias (Stubbersfield, Tehrani and Flynn, 2015). Numerous studies test survival (Burns, Burns and Hwang, 2011; Nairne and Pandeirada, 2008; Olds, Lanska and Westerman, 2014; Otgaar and Smeets, 2010; Soderstrom and McCabe, 2011), emotional (Adelman and Estes, 2013; Bann and Bryson, 2013; Bebbington et al., 2017; Heath, Bell and Sternberg, 2001; Stubbersfield, Tehrani and Flynn, 2017), and counterintuitive information (Banerjee, Haque and Spelke, 2013; Barrett and Nyhof, 2001; Norenzayan et al., 2006; Stubbersfield and Tehrani, 2013; Upal et al., 2007), yet support for these biases is mixed. Moral and rational biases have not been explicitly tested. The relative effects of these biases are not yet well-

explored, but the following studies have attempted to account for the presence and effects of multiple transmission biases.

Henrich and Henrich, using data collected from contemporary fieldwork in Fijian villages, suggested that there is likely a combination of kin and prestige bias in the adoption of food taboos by women, particularly when pregnant or breastfeeding (2010). The researchers found that women primarily learnt their taboos from female kin (and more likely from closer kin), and then from elders and wise women, compared to direct experience. As these taboos pertain to potentially toxic foods, this is a dangerous behaviour to learn asocially, and in this case, models are primarily kin, who they are both familiar with and similar to, and members of the community who hold prestige. This study was not designed to test multiple biases and this finding is based on the interpretation of ethnographic data. It is through observational studies that we might gather data that demonstrate the potential for multiple biases to concurrently influence the transmission of information. Therefore, it is imperative that we understand the relative effects of multiple biases and not conflate transmission effects.

Experimental methods have also been designed to investigate the effect of multiple content biases. Stubbersfield et al. (2015) investigated the effects of both social and survival biases on the transmission of urban legends. Seventeen urban legends were chosen because they were deemed to contain either social or survival content or both, and with 5-6 central propositions or events. Urban legends were shown to contain information across multiple domains including emotional content. Along with a control narrative about the formation of Cheddar Gorge, three stories that scored highly for social, survival and combined social and survival information respectively were presented to participants, who transmitted what they recalled of these stories to other participants in a three-generation linear chain. The social condition was consistently better recalled, followed by the combined condition, survival and finally control condition, suggesting that social information is preferentially recalled overall, but survival content is more attractive than unbiased information. This is a more realistic appraisal of how multiple biases affect transmission and the researchers attempted to control for other potential biases, like other studies (Bebbington et al., 2017; Heath, Bell and Sternberg, 2001; Mesoudi, Whiten and Dunbar, 2006). However, it provides a coarse-grained view of

the effect of these biases by ascribing stories to overall conditions without quantifying biases within them. This is problematic as any effect is credited to a bias without any understanding of how the bias works, how rich the content must be, and whether it is even the bias being tested that is influencing transmission.

Although there are limited attempts (Henrich and Henrich, 2010; Miu et al., 2018; Stubbersfield, Tehrani and Flynn, 2018, 2015) where studies account for or provide explanations about how multiple transmission biases can act upon information transfer, these experiments only address biases within the same content or contextual domain. The only current study of which I am aware that investigates both context and content does not explicitly test biases (Acerbi and Tehrani, 2018). In this experiment, participants were presented with pairs of 'quotations' that were attributed to either famous or unknown people or perceived as popular or unpopular and had to choose which quote they preferred. These quotations were not directly linked to content biases, but Acerbi and Tehrani used the content of these quotations as a proxy for these mechanisms. The quotes were about love, friendship, money, success, science, literature and some random quotes as controls. The 'author' had no effect on which quotation was preferred, suggesting that participants were more attuned to content than model effects. Here, the quotes themselves prevailed over context which is in keeping with the spread of viral quotations misattributed to famous figures (Acerbi and Tehrani, 2018).

Beyond the impact of multiple biases that may be used in the social learning domain, few studies have explicitly addressed or modelled the heterogeneity of the 'receiver' with respect to preferred or effective strategies. That is, people within a learning context may differ in their strategies, and individuals may differ across time. For example, what is relevant to an individual is culturally constrained and so we cannot generalise findings from studies that are broadly carried out with WEIRD participants. There are environmental and cognitive constraints such as time in which to learn information and memory constraints (Kormos and Trebits, 2011; Ward et al., 2016). Furthermore, different strategies may be more or less relevant across our lives. For example, children may initially learn from close kin (Hewlett et al., 2011; Lew-Levy et al., 2017) but employ success-based strategies as they get older (Henrich and Broesch, 2011; Jiménez and Mesoudi, 2019b; Kline, Boyd and Henrich, 2013).

Competitions demonstrate that people may use different strategies when presented with the same information. An online high-stakes (€10000) social learning strategies tournament was set up so that teams could compete for success in a complex simulation with changing environments (Miu et al., 2018; Rendell et al., 2011). Teams were provided with a computational challenge by the competition organisers and had to create solutions using MATLAB code. After this code was evaluated and a score given, the code and participant username was made public to all participants (Miu et al., 2018). This was an iterative process and teams had options to *innovate* (asocial learning), *observe* and *exploit* and build upon other's solutions (social learning) with associated costs. Teams used different strategies with varying success, but winning strategies often relied on social learning despite observation (social learning) simply reaffirming behaviour that they already knew (Rendell et al., 2011). Yet we also see in these competitions that social learning strategies are often confounded. Miu (2018) notes that dominant strategies such as success bias are quickly transformed into conformity bias over successive rounds of the game and so it is unclear what specific mechanisms are being exploited.

In the remainder of this thesis, I investigate the many competing biases that can influence transmission using experimental methods. I address some of the gaps in the literature by testing and quantifying multiple, and some understudied, biases across domains (Chapter 5). We use narrative as a realistic medium through which information has been passed down for generations where social, survival, emotional, moral, MCI and rational biases are present, *and* where, in our evolutionary history, this type of information would not have been transmitted devoid of contextual information such as prestige bias (Chapter 5). By doing so we can assess whether previous effects attributed to social transmission biases are conflated. I draw upon other disciplines: sociolinguistics (see Chapters 3, 4 and 7) and narrative discourse (see Chapter 6) to account for confounds that may be subsumed into bias effects. We introduce a relatively ignored cue of prestige: accent (Chapter 4) and carry out experiments and tasks that are designed to be replicable cross-culturally. Finally, I go beyond recall of information as a measure of transmission and determine how narratives and their content are transformed (Chapter 6), and how we negotiate and rely on prestige and/or dominance to ensure our voices are heard (Chapter 7), providing insight into the agency behind CT. By testing both retention and

construction (or transformation) of narratives, this research contributes to debates regarding whether fidelity is necessary for transmission.

Chapter 3: Darwinian Sociolinguistics

3.1 Introduction

There is a long established relationship between linguistic anthropology and sociolinguistics (Bucholtz and Hall, 2008; Hymes, 2000), based upon a common focus on the connections between language and society. Links include mixed-method data collection strategies encompassing qualitative ethnography and quantitative survey, and how the study of symbolic systems through a sociocultural lens explains both the variation in those systems as well as in social processes. More recently, language has become a core focus of the newer anthropological sub-discipline of cultural evolution (Dunn et al., 2011; Gavin et al., 2013; Kirby et al., 2016; Kirby, Cornish and Smith, 2008; Progovac, 2015; Richerson and Christiansen, 2013; Smith, 2011; Smith and Kirby, 2008; Steels, 2011; Tamariz, 2017).

If we accept that language is a cultural behaviour (Rosenbach, 2008), we would expect that linguistic variation could also be explained in the generalised terms offered by cultural evolution. It has been argued that cultural practices are subject to similar selection processes as biological features (Mesoudi, 2011; Richerson and Boyd, 2005), and the cultural evolutionary discipline, as it currently stands, has applied biological theory as its foundation (Gray, Greenhill and Ross, 2007). It is important to note that this does not necessarily imply that biological, cultural or linguistic processes are the same, but we do propose that there are conceptual parallels. Darwinian evolutionary theory is defined by three factors: 1) variation: there must be variation of a trait whether that is morphological or behavioural; 2) heritability: traits are heritable and passed from parent to offspring; and 3) differential fitness: different variants of a trait will have differential expression rates (Lewontin, 1970). In a linguistic sense, differential fitness refers to the proportions that a variant is used. These three factors are all applicable to language (Beckner et al., 2009; Blythe and Croft, 2012; Croft, 2000; Ritt, 2004; Rosenbach, 2008); therefore, we argue here that Darwinian theory can be extended from the study of cultural traits to linguistic variation and change.

In this paper, we contend that recent developments in the theory of cultural evolution can be fruitfully applied to variationist sociolinguistics, providing a complimentary framework for the interpretation of sociolinguistic variation. In the following section we examine the previous application of Darwinian cultural evolution to linguistics. Sections 3.2 and 3.3 illustrate how cultural evolution and variationist sociolinguistics are Darwinian in nature. It is important to note that both fields share terminology in some cases but with slightly different meanings. In this paper, terms with the subscript x_{ce} refer to meanings determined by cultural evolution and terms with the subscript x_{sl} refer to meanings determined by sociolinguistics. In section 3.4 we focus on social transmission biases, a cornerstone of cultural evolution, to explain the adoption of particular linguistic variants as an example of how cultural evolution theory can be applied to sociolinguistic data. Section 3.5 outlines why a cultural evolution framework is another tool that can be used in analysing sociolinguistic data and highlights the parallels between these two disciplines.

3.2 Previous applications of Darwinian theory to language variation and change

Multiple attempts have been made to demonstrate either parallels between language and biological evolution (Atkinson and Gray, 2005; Pinker and Bloom, 1990) or how language is subject to Darwinian evolutionary theory (Croft, 2000; Lupyan and Dale, 2016; Ritt, 2004; Rosenbach, 2008). The two subfields of linguistics most concerned with variation are historical linguistics and sociolinguistics, explaining both population-level change (or macroevolution) and individual variation events (or microevolution), which are also both explored in cultural evolution studies.

Sociolinguistics has developed a body of theory, which can be supplemented by a generalised evolutionary theory. However, the application of Darwinian evolutionary theory to sociolinguistics has been unpopular. One of the field's most prominent sociolinguists, William Labov, critiqued the application of Darwinian theory to linguistic variation (2001). Labov argued against the application of

Darwinian theory to language change as paradoxical. In his view, language change is maladaptive due to communication costs: information can be lost as forms and their associated functions change. However, Darwinian theory supposes variable fitness. Using this framework we might expect certain variables to be selected against, which could explain why some variants are unstable. Although language change may be seemingly maladaptive, there are other associated benefits that may outweigh the costs (e.g. gaining social capital through signalling peer-group identity over communicating effectively across generations). Irrespective of the communicative costs, linguistic traits are still subject to the three criteria (variation, inheritance and differential fitness), which suggest that Darwinian evolutionary theory is applicable (Lewontin, 1970).

Rosenbach's work on applying Darwinian theory to historical linguistics demonstrates how cultural evolution can be a useful framework in explaining linguistic variation (2008). Rosenbach draws upon the parallels between biological evolution and language evolution, and cultural evolution and language change and recognises that the process of language change can be driven by linguistic variation (variation), linguistic replication (inheritance) and linguistic selection (differential fitness). She recognises that one issue that has been problematic in transferring this biological metaphor is defining what the unit of selection would be. Within cultural evolution, there is still debate about what constitutes a cultural unit of transmission (Blackmore, 1998; Dawkins, 1976; Sperber, 2000; Sterelny, 2006a); this debate is also present in the linguistics literature (Croft, 2000; Ritt, 2004; Wedel, 2006). However, for the purpose of applying the cultural evolution tools presented in this paper to sociolinguistic data, we suggest that we use individual tokens (for example, phonemes if studying accent, or words if examining lexical choice) as potential transmission events with variants being in competition. The following sections demonstrate how cultural evolution (section 3.3) and sociolinguistics (section 3.4) can be characterised in this same Darwinian framework. Where previous models explain how language can fit in a Darwinian framework (Croft, 2000), I specifically examine how sociolinguistic variants sit within a cultural evolution framework. As language comprises many cultural traits, I provide clear analogues between other cultural domains and sociolinguistics in a similar vein to which Rosenbach (2008) has done for historical linguistics. By doing so, I suggest alternative ways to

interpret and study sociolinguistic phenomena using cultural microevolutionary methods and theory.

3.3 Darwinian cultural evolution

Cultural evolution is the study of how cultural behaviours and artefacts spread and change over time. It is the notion that cultural traits are subject to similar selection pressures as biological traits and is a driving factor in determining how humans behave. In this field, 'culture' is often referred to as socially transmitted information (Flynn 2008; Griffiths et al. 2008; Laland 2008; Mesoudi 2011; Richerson and Boyd 2005; Tan and Fay 2011). In an overview summarising the state of the discipline, Mesoudi defines culture as "information that is acquired from other individuals via social transmission mechanisms" but also notes that many definitions of culture have accrued as anthropology, as a field, has developed (2011, p.2).

Cultural evolution recognises that we learn variants of cultural traits from many potential sources and that there are a number of subdisciplines paralleling evolutionary biology that can be used to explain cultural diversity (Mesoudi et al. 2006). Despite Darwinian theory being developed in respect to biology, Darwin also drew parallels between biological and cultural variation, even going so far as to propose analogies between formation of species and languages (Darwin 1871 cited in Gray et al. 2007). Comparisons can be made between various aspects of Darwinian evolutionary theory and cultural evolution such as adaptation, drift, and selection. It is unlikely that a single mechanism will explain all transmission and variation (Sterelny, 2006a), a problem that previous Darwinian explanations of language evolution have encountered; however, for the purpose of this paper we will focus on selection. Like natural selection, cultural selection presupposes three conditions: variation, inheritance and differential fitness (Lewontin, 1970; Mesoudi, 2011; Richerson and Boyd, 2005). Linguistic traits are also subject to the same conditions.

3.3.1 Variation

Cultural traits such as aspects of material culture (e.g., styles of pottery or military patterns) or social norms (such as permitted forms of marriage or food taboos) are subject to variation both within and between populations. For example, whilst the phenomenon of 'turn-taking' in conversation is near universal (people generally do not speak simultaneously in conversation) there is both variation between language groups regarding the gap between turns (Stivers et al., 2009), as well as within groups, depending on the social action being performed (e.g., faster responses for confirmations than disconfirmations) (Kendrick and Torreira, 2015). Humans may hold many different variants in their cultural repertoire to be employed in specific contexts, such as different registers of speech (Schilling-Estes, 1998), for example, formal register in employment contexts and vernacular speech in conversation with friends.

Evolutionary theory distinguishes between the origins of variation and the maintenance or transformation of variants once arisen. Analogous with biological mutation, cultural traits can originate from complete innovation, as well as from transformation of prior variants. For example, polytetrafluoroethylene (Teflon) originally constituted a novel invention accidentally created as an attempt to make a chlorofluorocarbon refrigerant, however the non-stick properties enabled it to be later repurposed and used to coat cookware (Zabawski, 2010). Transmission biases, such as the frequency of a variant in the population, can act upon variation so that certain variants are preferentially selected, or can be used to explain why different groups may converge on particular types of behaviour, such as the communicative content of musical endings (Quaintrell, 2017). Like cultural traits, there are similarities in the production of linguistic variants, which can carry information about the individuals possessing the variants by signalling information about them (e.g., where they come from, in the case of accent).

3.3.2 Inheritance

Cultural traits are 'heritable' from multiple sources resulting in opportunities for several different types of transmission. In particular, cultural traits can be transmitted from biologically unrelated individuals and, with the exception of cognitive constraints and time budgets, there is no limit to the number of possible cultural parents (Enquist et al., 2010; Eriksson and Coultas, 2012). For this reason cultural evolution views transmission in three ways: vertical, horizontal and oblique (Borgerhoff Mulder, Nunn and Towner, 2006; Cavalli-Sforza and Feldman, 1981; Mesoudi, 2011). Vertical transmission refers to transmission of cultural traits from biological parents to offspring which can be either uniparental or biparental. Oblique and horizontal transmission can be between non-biological relations and there are no limits to the number of cultural parents or offspring. Oblique transmission refers to transmission of traits from the parental generation, and horizontal transmission refers to intragenerational transmission (Mesoudi, 2011; Tehrani and Collard, 2009). Horizontal transmission often happens by diffusion and is characterised by geographical clustering of a trait (Guglielmino et al., 1995), which is demonstrated by the spread of innovations.

However, multiple transmission pathways can be employed simultaneously. For example, it has been found that music in 16 Austronesian-speaking groups has been transmitted both vertically (maintaining linguistic differences ensures communicative understanding) and horizontally (for music typology) (Rzeszutek et al. 2012). Reyes-García and colleagues (2009) were able to determine that the Tsimane' rely on oblique transmission in addition to vertical transmission to gain knowledge of ethnobotany during childhood, which may be due to high rates of social visiting within the group leading to sharing of knowledge. Likewise, language acquisition is scaffolded by whoever is in a speaker's language community and to whom a speaker has exposure. Initial language acquisition will be intergenerational through vertical or oblique means, though stylistic language variants gained after this phase can be through either of these transmission routes, or by horizontal transmission through peers as can be seen in word frequency in Twitter users (Bryden, Wright and Jansen, 2018).

There are many mechanisms that can be used to transmit cultural and linguistic variants from one individual to another including imitation, emulation, teaching or a combination of mechanisms (Caldwell and Millen, 2009; Rendell et al., 2011). Imitation is the process by which an individual learns a behaviour by copying the action of another. Emulation is when an individual learns a behaviour or trait by copying the result of an action. For example, an artist may learn to paint by copying the styles of other painters without seeing the original painter and the techniques they used. Linguistic variants can be transmitted by imitation; for example, an infant copying an unfamiliar word in similar contexts; emulation; for example, copying a linguistic register by analysing transcripts of speeches; or teaching; for example, being taught sign language in a class.

3.3.3 Differential fitness

Whilst new cultural traits can be innovated through individual learning, many are learnt from other individuals (Galef, 2009; Rendell et al., 2011). Multiple learning strategies result in numerous variants of a trait in a population. For example, storytelling is found across all cultures (Scalise Sugiyama, 1996) and there are many variants of the same story found across cultures (Ross et al. 2013; Tehrani 2013b). However, within groups there are also alternates that compete for salience. With exposure to multiple variants there is a choice to express some single variant at a given opportunity. Even though we may hold multiple mental representations of a trait, it is the expression of a trait that is in competition, and which in turn can be transmitted to and expressed by another person. For example, a person may know how to tie multiple types of knots when tying a tie, however, these multiple knots are in competition as only one knot can be tied at a time. We see this in language where we may have many linguistic variants but will use particular variants in regard to specific contexts. This might be done by altering the proportions of usage of a particular linguistic variant in order to signal group identity when it is relevant. For example, Bucholtz (1999) found in the use of formal registers and 'superstandard' speech, an exaggeration of a non-localised variety which often indexes prestige, to promote a 'nerd girl' identity in a secondary school in California. For example, it was found that 'nerds' resisted fronting of /uw/ and /ow/ (a vowel

shift associated with trendy California teenagers) and avoided slang in favour of formal lexical choice such as Greco-Latinate forms. The expression of particular variants over others can be explained in cultural evolution studies by transmission biases.

Transmission biases were put forward by Boyd and Richerson (1985) as a way of explaining why particular variants are more likely to be transmitted over an alternative (see Chapter 2). This could be due to an advantage it provides making it beneficial to an individual, or because it is particularly memorable or relevant, causing it to be adopted by many people. As such, this trait reaches stability in the population (Acerbi and Bentley, 2014). Alternatively, a trait could be transmitted even when it is maladaptive because it is associated with individuals or other traits that provide cultural benefits. For example, it has been found that suicide rates rise and cluster around times when a celebrity or politician has died by suicide, a phenomenon known as 'copy-cat suicide' (Mesoudi, 2009b). Copy-cat suicide is a hugely maladaptive behaviour and has been previously attributed to prestige bias, wherein individuals are copied because they are considered prestigious due to other characteristics, or to similarity bias, wherein the person copied share other similar traits. Although copy-cat suicide is maladaptive for biological fitness, the behaviour is culturally attractive enough to be remembered and copied by other individuals suggesting that the behaviour has higher cultural fitness. As prestige bias may drive copy-cat suicide, the behaviour indexes the social status of the model and may have an impact on reputation through, in this case, collective memory. Though modelling these proposed biases, Mesoudi, however, found that these biases alone do not explain mass clustering. Mesoudi puts forward an alternative hypothesis suggesting that in addition to prestige and similarity biases, mass media and its social influence contributes to national mass clustering of suicide rates (2009b). Maladaptive linguistics behaviours can also be retained due to biases. For example, Roberts and Fedzechkina (2018) found than when people were exposed to a language with dialects with and without case markers, conditions where participants were socially biased towards speakers using case markers lost case markers at a slower rate compared to non-biased speakers or speakers who were biased towards not using case markers. The use of case markers has a cognitive cost on production and processing as it is redundant when there is an alternative dialect without case

markers. However, social biases mitigated this maladaptive behaviour to slow the decline of use of case markers (Roberts and Fedzechkina, 2018).

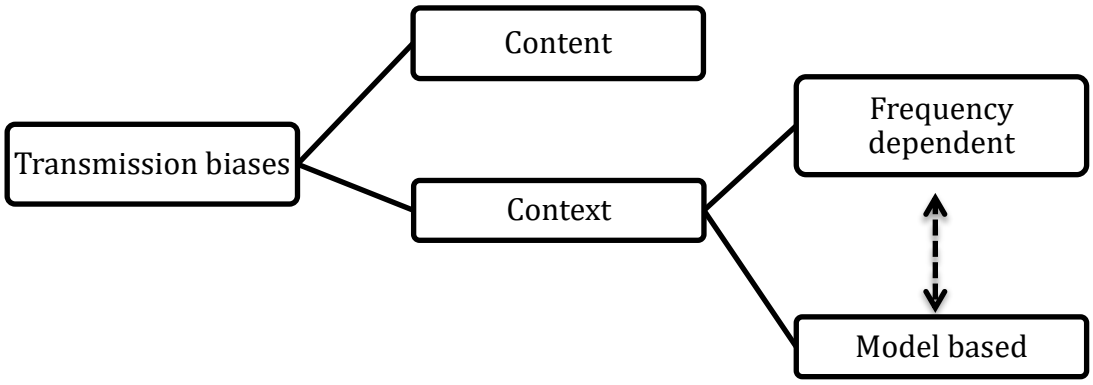


Figure 3.1. Hierarchy of transmission biases

Transmission biases are usefully split into two categories: context and content biases, sometimes with the former split into frequency-dependent and model-based subcategories (Figure 3.1) (Boyd and Richerson 1985; Henrich and McElreath 2003; Mesoudi 2011). Content biases refer to variants chosen because they are memorable themselves or have particular relevance to the person selecting them. Context biases refer to types of strategies used when adopting a particular variant. Model-based biases are invoked when an individual chooses to replicate a variant based on who already demonstrates this variant, while frequency-dependent biases are determined by the proportion of the population using a particular variant. The two subcategories within context biases are interrelated because model-based biases can lead to higher frequency and vice versa. Both types of context bias can also contain social information: models can be chosen based on reputation and group identity; and a variant can become more frequent in the population if it is valued. The interaction between frequency-dependent, model-based, and social biases is intuitive in terms of linguistic trait selection when looking at sociolinguistic prestige and forming group identities.

3.4 Darwinian sociolinguistics

Language variants can be considered 'heritable' and compete for usage in different contexts, which is enough to consider language as Darwinian in its basic structure (Lewontin, 1970; Richerson and Boyd, 2005). The sociolinguistic focus on variation suggests that the discipline may benefit from the emerging Darwinian framework of cultural evolution. It stands to reason that sociolinguistic variants are subject to the same social learning mechanisms and transmission biases as other cultural traits, as well as meeting the criteria for Darwinian evolution. The following sections will provide examples of how the sociolinguistic studies fit into a Darwinian framework.

3.4.1 Variation

Since its inception, variationist sociolinguistics has undergone three 'waves', each building upon the previous wave, aiming to ascribe social meaning to language change (Eckert, 2012). The social categories (e.g. social class, gender) in the first wave continue to permeate throughout the successive waves and, by indexing group identities, allow us to interpret sociolinguistic data within cultural evolution frameworks. The exploration of social networks and communities of practices and their impact on variation, as considered in second wave studies, are often explored by ethnographic methods that are shared with anthropology. As there is movement towards addressing agency in third wave studies, there is a greater need to understand why an individual chooses a particular variant. Transmission biases can be used to explain these decisions, for example, stable sociolinguistic variants could be attributed to frequency-dependent selection (i.e., a variant may be preferentially selected and maintained as it is already prevalent in a population).

In his review of linguistic social markers, Roberts (2013) argues that for linguistic social markers to function, there must be variance. Social markers have evolved to allow individuals to recognise whether a person is in-group or out-group (Fitch, 2004; Halpin, 1991). As variance in linguistic features provide a good source of social markers (Cohen, 2012; Roberts, 2013), evolutionary theories can be fruitfully applied to analyse dependence on these markers to evoke cooperative and antagonistic behaviours.

Language is variable across multiple domains from lexical choice to pronunciation (Evans and Levinson, 2009). This variation can be due to innovation and the diffusion of those innovated variants, which, if successful, can lead to language change (Milroy and Milroy, 1985). These innovations may occur due to linguistic constraints, for example the Great Vowel Shift in Standard English followed set patterns accounting for available phonetic space as well as creating multiple phonetic variants (Bauer, 1979; Torgersen and Kerswill, 2004). Alternatively, new variants may appear because of conscious change and agency of individuals using language to express identity. This has been demonstrated in Multicultural London English where multi-ethnic friendship networks have influenced the conscious use of innovative variants, which could be explained in terms of exposure and frequency. Different friendship networks were more likely to adopt different innovations based on the ethnic groups included, suggesting that particular innovations also signal identity or model-based biases (Cheshire et al., 2008). This has also been demonstrated through experimental games where participants have to identify partners through innovation using an artificial language (Roberts, 2010). Those who are able to invent clear signals of identities or 'secret handshakes' are more successful in the task, suggesting that we are more likely to innovate when there are stakes. In sociolinguistics, variability is measured by the proportion of variant usage, and variables are thought not to be undergoing linguistic change when the frequency of 'standard' and 'non-standard' variants are considered to be stable in the population.

3.4.2 Inheritance

Like other cultural traits, linguistic variables are heritable based on our exposure to variants. Inheritance in sociolinguistics can be seen as the transmission and diffusion of variants. Cultural evolutionists and sociolinguists employ similar frameworks to explain how variants spread through 'transmission' and 'diffusion'. Labov argues that transmission$_{sl}$ is native language acquisition of children from an older generation and diffusion$_{sl}$ is when there is borrowing across dialects and languages (Labov, 2007). Labov's definitions of both transmission$_{sl}$ and diffusion$_{sl}$ can be compared to transmission$_{ce}$ where transmission$_{sl}$ refers to vertical and

oblique transmission$_{ce}$ and diffusion$_{sl}$ refers to horizontal transmission$_{ce}$ (Cavalli-Sforza and Feldman, 1981). The distinction between vertical and oblique transmission$_{ce}$ allows for a nuanced interpretation of high and low frequency variants respectively, whilst horizontal transmission$_{ce}$ can be used to explain the age-grading phenomenon where there are differences in speech throughout an individual's lifetime (Wagner, 2012). In this case there are many transmission events where multiple variants can be accrued through different mechanisms such as vertical transmission$_{ce}$ in initial language acquisition and horizontal transmission$_{ce}$ during adolescence.

Diffusion in both sociolinguistic and cultural evolution literature is often attributed to migration. The diffusion$_{sl}$ of particular linguistic variants is seen as a secondary process to transmission$_{sl}$. Those who employ variants that are non-native to the group or community are seen to accommodate to others and, by doing so, generate and maintain linguistic diversity (Labov, 2007). This diffusion pattern is often seen in urban developments where linguistic features in large cities are subsequently found in smaller surrounding settlements (Mooney, 2015) in what is termed a *gravity model* (Nerbonne, 2010; Trudgill, 1974). An example of this could be 'h-deletion', a feature of London English, found in Norwich despite Norwich being located in an 'h-pronouncing' region of rural East Anglia (Trudgill, 1974). Token-based data are lacking within the cultural evolution literature but are ideal for testing cultural evolution models. In cases where linguistic features from large cities are found in areas that are geographically distant, this could be due to status ascribed to the city, such as [f] tokens instead of [θ] in areas surrounding Bristol and London and the gradual move to more northern cities based on population size (Kerswill, 2002), or diffusion through migration and the subsequent accommodation, or dialect-levelling, to a large suite of linguistic variants.

3.4.3 Differential fitness

With linguistic variables, there is competition to express a particular variant in a given context. From a sociolinguistic perspective, differential fitness is driven by social factors that influence the selection of variants. These influences can be likened to social transmission biases, as speakers will adopt variants based on frequency

and exposure to variants, or to accommodate to other speakers based on status. D'Arcy and Tagliamonte's work on the use of the relative pronouns *who* or *that* showed that in mixed-sex dyads the non-standard *that* variant is favoured whilst the standard *who* is used 25% more when women are talking to other women (2010). This might suggest that there is a sex-based bias for correct forms in female-female dyads or a bias for informal forms in mixed-sex dyads. Alternatively, certain variants may be preferentially selected because they signal group identities and the proportions may be as fluid as the context with which they are associated. For example, second generation Greek migrants in Australia, despite evaluating their ethnic language favourably, have been shown to reject foreign accents including their parents' in order to better assimilate with the wider community whilst still maintaining their ethnic identity (Callan and Gallois, 1987). Differential fitness drives selection so is a clear focus for the application of Darwinian theory to sociolinguistics.

3.5 Importing the transmission bias framework to sociolinguistics

The cultural evolution perspective on differential fitness (or *competition*) could be particularly useful for interpreting variationist sociolinguistic data. Variationist sociolinguistic studies investigate how the proportion of variant usage varies under different conditions, but there are limited specific mechanisms invoked to explain why this variation comes about and why particular choices are made. Variationist sociolinguistics focuses on broad patterns across categories or group level selection. However, including the cultural evolutionary perspective also allows us to examine variation at the individual level. Cultural evolution theory relating to the transmission bias framework provides two useful mechanisms that can be used to interpret language change: guided variation and cultural selection (Richerson and Boyd, 2005). With guided variation, people acquire information from other individuals and modify their own output based on their own individual experience, whereas cultural selection involves no modification of traits (Mesoudi, 2011). Analogues of these processes in Darwinian biological evolution are Lamarckian evolution (or blended inheritance) for guided variation and natural selection for

cultural selection. It should be noted that natural selection can act directly on cultural variants if there is a relevant effect on biological fitness, whereas cultural selection works independently of natural selection, using the same principles to increase cultural fitness (Mesoudi, 2011) (see section 1.1.2). Framing sociolinguistic variation in terms of transmission biases can help explain why a variant may be chosen over another at a given time through cultural selection (Richerson and Boyd, 2005). Humans have evolved biases (Haselton, Nettle and Murray, 2015) which linguistic variants can evoke to different extents. We would expect that where there is exposure to multiple variants, a variant which acts on a bias will be more successful as it is easier to retain and transmit, and will therefore also be selected for at the population level. Table 3.1 gives examples of a number of biases that are well-defined and studied in the cultural evolution literature, some of which can be applied to sociolinguistic data. For example, although we can hold multiple variants of a phoneme, we may be more likely to use a variant that we hear more often due to frequency-dependent bias. One might express more frequently-heard variants so as to index similar categories to our peers.

Table 3.1. Examples of transmission bias studies.

Type of Bias	Bias	Definition	Support for Bias
Content	Social	Information about other individuals and their interactions	Social information about relationships in oral narrative recall (Mesoudi, Whiten and Dunbar, 2006); Social information in urban legend recall (Stubbersfield, Tehrani and Flynn, 2014)
	Survival	Information pertaining to specific fitness-related goals	Survival based word list recall (Nairne, Thompson and Pandeirada, 2007); Survival based word list recall in adults and children (Otgaar, Smeets and van Bergen, 2010)
	Emotional	Elicits an emotional response	Distribution of urban legends with emotional elements(Heath, Bell and Sternberg, 2001); Decisions to transmit narratives eliciting emotional responses(Peters, Kashima and Clark, 2009)
	Minimally Counterintuitive (MCI)	Violates ontological properties of folk-psychology, folk-biology and folk-physics	Counterintuitive information in children's immediate and delayed narrative recall(Banerjee, Haque and Spelke, 2013); Counterintuitive information in word list recall and popularity of fairy tales (Norenzayan et al., 2006); Influence of counterintuitive elements on cultural phylogeny of fairy tales (Stubbersfield and Tehrani, 2013)
Context (Frequency-dependent)	Conformity	Positive frequency bias: popular traits are favoured	Change of response based on frequency information in line length, rotated shape recognition and pitch recognition tasks (Morgan et al., 2012b); Reliance on frequency-based social learning when determining longest line length (Muthukrishna, Morgan and Henrich, 2016)
	Anti-conformity	Negative frequency bias: unpopular traits are favoured	Facial hair is perceived to be more attractive when it is rare (Janif, Brooks and Dixson, 2014)

Type of Bias	Bias	Definition	Support for Bias
Context (Model-based)	Prestige	Copy individuals who are 'prestigious'	Decisions in an arrow-making task based on examples provided by participants dependent on attention-based cues (Atkisson, Mesoudi and O'Brien, 2012)
	Familiarity	Copy individuals who are 'familiar'	Decisions on contraceptive use based on the views and education status of neighbours (Colleran and Mace, 2015)
	Kin	Copy individuals who are related to you	Vignettes about reproductive decisions lead to responses in favour of having children if characters portrayed are kin (Newson et al., 2007); Children learn subsistence skills from parents due to increased exposure (Lew-Levy et al., 2017)
	Age	Copy individuals of a particular age group	Children believe testimony from adult experimenter over their own experience (Jaswal, 2010); Children direct questions about food to adults and questions about toys to other children (Van der Borght and Jaswal, 2009)
	Sex/Gender	Copy individuals of a particular sex/gender	Sex based division of labour led to sex based teaching of particular skills in Aka pygmies (Hewlett and Cavalli-Sforza, 1986)
	Success	Copy individuals who are 'successful'	Copying successful individuals in an arrow-making task in multimodal environments (Mesoudi, 2008)

3.5.1 Content biases

Content biases increase the chance of a cultural trait being transmitted because it is relevant to the receiving party or it is sufficiently memorable to be transmitted faithfully. These content biases can be innate: some variants are unlikely to be popular due to innate biological biases (for example, sawdust as flavouring); whilst others are culturally learnt, such as a preference for flavouring popcorn with salt or sugar (Henrich and Henrich, 2007). Sperber's theory of 'attraction' argues that there are cognitive optima, a sweet-spot of variants that have evolved over time, which results in these variants being particularly memorable or relevant (1996). Cultural variants that are closer to these optima are more likely to be transmitted and replicated resulting in these variants becoming stable at population level. Content biases are a form of cultural selection whereby the trait itself is attractive or memorable and therefore more likely to be copied. As traits that act on content biases are more likely to be transmitted we would expect greater success in transmission of these variants and therefore they are likely to have high cultural fitness. One example of an attractive linguistic feature might be onomatopoeic words, where phonemes themselves have an iconic link to their meaning, and phonesethemes which cluster around particular meanings (Winter et al., 2017). Using a cognitive framework, we can explain that these features are likely to be propagated due to content biases favouring the properties of the trait (Acerbi and Bentley 2014).

Although not all content biases explored in the cultural evolution literature (see Chapter 2) are intuitively relevant to linguistic variation, utilising this framework can provide new questions (for example, minimally counterintuitive bias is unlikely to be applicable to high frequency linguistic variants but may explain the stability of low-level variants). Other biases have a clearer application to language variation: it is well established that certain phonetic and lexical variants index particular social categories such as social class and ethnicity. By extension, we could describe these features as carrying social information: socially-biased. For example, we might switch between vernacular and formal registers due to relevance and social context. Emotional bias may also be relevant as there has been much work establishing that people attribute emotional valence to words (Bestgen, 1994;

Kensinger and Corkin, 2003; Kensinger and Schacter, 2006; Scott et al., 2018). For example, the turnover of swear words has been considered in terms of 'pragmatic bleaching' so that the emotional impact is sustained (Fägersten and Stapleton, 2017; Kleinknecht and Souza, 2017).

3.5.2 Context biases

Context biases usually fall into two categories: frequency-dependent and model-based (Boyd and Richerson 1985; Mesoudi 2011; Rendell et al. 2011). Frequency-dependent biases mean that a cultural trait is more or less likely to be learned or transmitted depending on how often it is observed in the population. The term 'frequency-dependent' can be problematic because unbiased random copying can result in a similar distribution of variants in subsequent generations in the absence of other transmission biases (Mesoudi and Lycett, 2009). This distribution is due to common variants remaining stable or gaining usage within the population and uncommon variants becoming rarer. However, conformity (positive frequency-dependent bias) and anti-conformity (negative frequency-dependent bias) go beyond random copying by actively favouring particular traits based on their distribution in the population (Mesoudi, 2011; Richerson and Boyd, 2005). Predictions of these biases have been modelled within the cultural evolution literature resulting in r-curves for frequency-based guided variation and s-curves for biased variation including both content and conformity (Cavalli-Sforza and Feldman, 1981; Mesoudi, 2011). These s-curves are also found within the linguistic literature when variants are weighted which is comparable to biased transmission (Blythe and Croft, 2012).

Depending on frequency-dependent biases is usually a low-risk strategy for social learners as the variant should not be favoured in the population if it is harmful. However, when other beneficial behaviours are associated with harmful behaviours, these harmful behaviours may still be transmitted if the benefits outweigh the costs. For example, Howard and Gibson found that in areas where there was high frequency of female genital cutting, a harmful cultural practice, women had higher reproductive fitness suggesting that there may be other practices of the group which confer benefits (Howard and Gibson, 2017).

Model-based biases refer to when learners actively choose a particular cultural variant based on the characteristics of others who express that variant (Boyd and Richerson 1985; Mesoudi 2011; Kempe and Mesoudi 2014). Models are chosen for many reasons such as prestige or age, whether they are familiar (or 'in-group'), or for trait-specific reasons such as success derived from exhibiting a specific variant (Rendell et al., 2011). It is important to note that individuals have cultural packages (i.e. a suite of cultural traits) that are transmitted and not all cultural traits that are transmitted from the model to the recipient will be advantageous or relevant. This is because, unlike social learning strategies, the bias affects the person as a whole as opposed to the individual trait, so multiple traits are likely to be adopted. A person may be considered prestigious due to success in one domain. However, their status makes them a likely model across other domains as can be seen in celebrities endorsing products unrelated to their skills (Erdogan, 1999; Tehrani, 2013b). For example, Wood et al. (2012) found that children copied both the functional and the non-functional, irrelevant actions of an adult demonstrator but not the non-functional actions of a child demonstrator. Additionally, the age of the models was more important than whether the demonstrator stated that they knew or did not know how to complete the task despite knowledge state being a more relevant bias.

Context biases including model-based biases can work through guided variation or cultural selection. For example, context biases can be demonstrated through looking at accommodation and prestige of linguistic variants. 'Accommodation theory' suggests that we hold different linguistic variants but use whichever is contextually appropriate based on our interlocutors (Giles et al. 1991). Accommodation is directional and speakers can converge on particular variants or diverge to maintain or exaggerate difference, indexing social information. Here an individual may evaluate another person and based on their perception alter their own behaviour (guided variation). For example, if an individual shared a variant with another but chose to accommodate divergently, they would not copy the trait exactly but modify their output to signal difference. However, as it is an interactional variant, accommodation can demonstrate model-based biases such as prestige_{ce}. What is considered to be prestige_{ce} in anthropological studies would be considered 'social values' in sociolinguistics, which recognises that status is a property of people

as opposed to a linguistic form (Milroy, 2007). Although, in cultural evolution, prestige is conferred upon individuals, prestige bias would act upon linguistic tokens in a sociolinguistic context because they index social value. Here, higher social valued tokens may be transmitted more readily (cultural selection). Certain linguistic features, often associated with standard dialects, belong to those with high social value and so are considered to have 'overt prestige$_{sl}$' and adoption of the features can be considered 'change from above'**.** However, some non-standard features also gain 'covert prestige$_{sl}$' as speakers subconsciously or unconsciously use variants more frequently, considered 'change from below' (Hawkey, 2016; Labov, 2011). In this case, whilst the feature itself may not initially have high social value, as it becomes more common the group that uses it gains greater social value (Llamas, Mullany and Stockwell, 2007). The inability to express why variants are chosen, in respect to covert prestige$_{sl}$, means that this phenomenon is difficult to study using sociolinguistic methods alone or methods based on reports. However, by framing prestige in terms of transmission biases we can account for both types of prestige$_{sl}$.

3.5.3 Interdisciplinary successes

While there have been many successful models of how language evolution are subject to Darwinian evolutionary selection and pressures (Aoki and Feldman, 1987; Atkinson and Gray, 2005; Baxter et al., 2006, 2009; Beckner et al., 2009; Brighton, Kirby and Smith, 2005; Chater and Christiansen, 2010; Christiansen et al., 2002; Croft, 2000; Dunn et al., 2011; Fitch, 2005; Kirby and Hurford, 1997; Nowak, 2001; Nowak and Krakauer, 1999; Pinker and Bloom, 1990; Ritt, 2004), we have also seen an update in specifically studying individual level language variance in evolutionary terms (Kirby, Cornish and Smith, 2008; Roberts and Fedzechkina, 2018; Scott-Phillips and Kirby, 2010; Sneller and Roberts, 2018). Sneller and Roberts (2018) demonstrate how variants are subject to selection by what can be interpreted as transmission biases. In this study two types of variant are distinguished: 1) variants that are associated with a particular social group; and 2) variants that are associated with a trait attributed to a particular social group. In this case, we might liken the former to prestige or another model-based bias, and the latter to a content bias.

In Sneller and Roberts' experiment simulating dialect contact, participants played a game that required them to communicate using two dialects of an alien language (Burl and Wiwo) (2018). In this game, participants gained points by getting resources from other players by either trading or fighting. Although Wiwo players adopted Burl variants in all conditions, when Burl variants were associated with toughness, Wiwos adopted significantly more Burl variants. When toughness no longer became relevant in the game, the association between Burl variants and toughness ceased and the rate of adoption was lower (Sneller and Roberts, 2018). Here, relevance rather than group identity becomes a more important factor in the propagations of variants and we can liken this to content-biased cultural selection whereby a variant has greater fitness due to its inherent qualities.

3.6 Concluding remarks

Although previous applications of Darwinian theory to linguistic variation have had a mixed reception, linguistic variation meets the conditions to be considered Darwinian when Darwinian theory is stripped down to its central tenets: variation, inheritance and differential fitness. By describing linguistic variation in terms of a Darwinian framework, variationist sociolinguistic studies can draw upon a generalised evolutionary theory. Cultural evolution theory in particular can offer a model of the mechanisms of individual choice and agency. Transmission biases can provide a nuanced explanation of variation within and between macro-social categories and add another dimension to the interpretation of sociolinguistic data, going beyond descriptivism to explaining why particular variants are favoured. For cultural evolutionists, the data-rich, token-based variationist approach provides an ideal opportunity for testing often-theoretical cultural evolution tools, especially those looking at the frequency of transmission interactions and behaviour. Both disciplines share a common goal: to describe and explain variation, and already share data collection methods such as the use of ethnography and quantitative methods. Similar work on variation and change is being carried out in cultural evolution studies and may provide additional methods for investigating variation as well as different interpretations.

Chapter 4: Evaluations of Accents can be used to Demonstrate Prestige[1]

4.1 Abstract

Sociolinguistic studies have established that people make judgements based on speaker accent. Standard and non-standard accents have differing levels of prestige and demonstrate variation across attitudinal terms. As prestige can increase the likelihood of information transmission, we explore variation in accent prestige to determine whether accent can be used as a measure of prestige in social transmission experiments. Participants (*n*=152 US; 142 UK) were presented with normalised recordings of a standard passage, containing lexical terms that highlight phonological differences between accents, and read by middle-aged male speakers representing a range of eight accents from their country of residence and two from the alternative. Participants were asked to rate the speakers on 25 different personal qualities including traits associated with prestige and friendliness. As predicted, participants rated the standard accents favourably for prestige across both locations. Location-specific non-standard accents were perceived as having lower prestige. Accents deemed as having lower prestige were also perceived as being friendlier. We assert that accent can be used as an indicator of prestige in the absence of other prestige information, and demonstrate the importance of locally calibrating stimulus accents for cross-cultural study in prestige-based social transmission experiments.

[1] This research was carried out in collaboration with Richard Berl (RB), Michael Gavin (MG) and Fiona Jordan (FJ). AS, RB, MG and FJ conceived the study. AS and RB designed the questionnaire with input from MG and FJ. RB collected the US data and AS collected the UK data. AS analysed the data and created the figures. AS wrote the chapter.

4.2 Introduction

Stable cultural evolution (CE) is dependent on social learning to transmit information. As previously discussed in Chapter 2, social learning studies consider a range of context and content biases to explain why some variants are favoured over others (Bebbington et al., 2017; Boyd and Richerson, 1985; Boyer and Ramble, 2001; Efferson et al., 2008; Jiménez and Mesoudi, 2019b; Kendal, Giraldeau and Laland, 2009; Kendal et al., 2018; Mesoudi, Whiten and Dunbar, 2006; Mesoudi, 2011; Nairne, Thompson and Pandeirada, 2007; Richerson and Boyd, 2005; Stubbersfield and Tehrani, 2013). Whereas many social transmission bias experiments have previously focused on single biases, there has been a move toward testing multiple biases concurrently both to test bias interaction and to create more representative experimental methods (Acerbi and Tehrani, 2018; Henrich and Henrich, 2010; Muthukrishna, Morgan and Henrich, 2016; Stubbersfield, Tehrani and Flynn, 2015). These studies usually test biases across either context or content domains. However, there are many real-world examples where both context and content biases can be evoked (see Chapter 5). Testing across domains adds another dimension of complexity and so there is a greater need to establish measures that can realistically categorise context-based biases. Furthermore, it is important to use cues that are broadly relevant and index informational cues that are present in real life scenarios.

In this chapter, we put forward accent as a simple instantiation for prestige and in-group biases based on sociolinguistic literature and experiments. This research contributes to the literature on language attitudes and provides both regional and cross-cultural data regarding accent perception. Comparisons with other accent perception studies allow us to determine the stability of accent perception. If we can establish the utility of using accent as a cue for prestige, we can expand the variety of experimental designs we use, and ground social transmission studies in increasingly realistic behaviour.

4.3 Literature Review

4.3.1 Accent as a signal of group identity

Accent has been shown to be sufficiently varied to stimulate differences in social preferences for even preverbal infants (Kinzler, Dupoux and Spelke, 2007). Accent is the variation in how we pronounce words and can index a variety of phenomena including social factors and geographic origin. We can typify accents based on many linguistic variables. A linguistic variable is a specific linguistic element that can have several manifestations; each variant is a possible realisation. For example, if we were to take the pronunciation of <a> in 'bath' or 'trap'; the variants are [aː] and [æ] respectively in Received Pronunciation (RP), but both are [æ] in General American accents (Wells, 1982). We are able to hold different variants of speech in mind, but can only express a single one at a given time. The proportions of specific variants we use determine our accent.

Accent is an indicator of regional differences (Alford and Strother, 1990; Clopper and Pisoni, 2006; Labov, Ash and Boberg, 2005; Shackleton, 2007; Wells, 1982) and as such can be a marker of group identity (Coupland and Bishop, 2007). Accent is an honest signal; whilst some people can mimic other accents, it is difficult to maintain, especially when vernacular speech is elicited (Cohen, 2012). Here, honesty doesn't mean that the cue itself is consciously chosen but that the signal provides reliable information about the signaller themselves (Fitch and Hauser, 2003). Accent can provide much personal information about an individual: we may be able to identify their age, gender and where they are from. Given that model-based biases index these personal characteristics, accent may be a useful signal to communicate this information. This review will focus on how accent has been used as an indicator of personal characteristics and how perceptions towards different accents vary.

There is evidence to suggest that we use accent to determine different types of information about individuals and also with whom we associate and trust. For example, Cohen (2012) argues that accent markers meet the requirements to act as a 'tag' that enables us to discriminate between individuals enabling cooperation (i.e. shared accent might signal in-group identity and, therefore, those with whom we

may wish to cooperate). She argues that accent acts as a hard-to-fake signal and, therefore, impervious to exploitation, which demonstrates aspects of social identity. Although accent is often used to place people within a group context, Cohen argues that it is individualised and comparable on a gradual scale as there aren't distinct boundaries between accents. Individuals differ in variant usage and there is a geographical continuum for accent. As such, accents are dynamic and variation within an individual's speech can express membership to different groups as well as deviations from norms in the case of accent switching (Cohen, 2012). I would argue that accent is not prescriptive and can encompass many variants; *style* can be individualised when we try to portray specific information about ourselves (Eckert, 2012). This is important to address when we consider transmission: for social learning to take place there is both stimulus and audience, transmitter and learner. Both agents play a role in the success of transmission: if the event is driven by the transmitter, they can adapt their style if they are aware of the cues that present themselves as good models (e.g. accommodation (see Chapter 3) when explicitly teaching.) However, if a recipient drives transmission, we might expect greater reliance on accent as a robust signal of group identification. The tension between honest signalling and dynamic membership of multiple groups is difficult to resolve, yet the studies described below suggest that accent is a reliable cue for different types of social information and that we respond differently to different accents.

Lev-Ari and Keysar posited that non-native sounding speakers are less credible due to 'processing difficulty' (2010). In an experiment with native American English speakers, participants were asked to rate the credibility of statements read in English by native-accented speakers, mild-accented (Polish, Turkish, Austrian-German) speakers, and heavy-accented speakers (Korean, Turkish, Italian). Participants were told that the speakers had been given the statements by the experimenter so decisions about whether statements were true or not should not have been based upon assumed knowledge state of the speakers. Participants rated native-accented speakers as more likely to speak the truth and both mild- and heavy-accented speakers' statements as more likely to be false. When this experiment was repeated with priming about accents and when participants were asked to rate the difficulty in understanding the speakers, native- and mild-accented speakers were rated as being more truthful and heavy-accented speakers were rated

as saying more false statements (Lev-Ari and Keysar, 2010). This suggests that foreign-accented speakers are deemed to be less trustworthy even when people are primed to accent difference. The difference in results for mild and heavy accents across both studies suggest that we subconsciously make decisions about others based on accent and that accent signals group identity.

Even pre-school aged children use accent as cues of social preferences (Kinzler et al., 2009) and trust (Kinzler, Corriveau and Harris, 2011), and are able to differentiate between native- and foreign-accented speakers and endorse the behaviour of native-accented speaker. Four to five-year-old native English-speaking children were presented with videos of native-accented and foreign-accented speakers of English. The speakers were bilingual in English and Spanish and recorded videos in English in both American and Spanish accents, demonstrating different functions of a novel object. The children were asked to identify who they would ask to demonstrate what the novel object did. They were then provided with the novel object to demonstrate themselves what the object did, endorsing a particular behaviour. In both cases, children asked the demonstrator and endorsed the behaviour of the American accented speaker suggesting that shared accents are use as a cue for models of behaviour. This result was also found when accent priming used nonsensical words from Lewis Carroll's poem *Jabberwocky,* further suggesting that children are using accent cues over intelligibility (Kinzler, Corriveau and Harris, 2011).

Other studies with children have found that accent is used as an indicator of social preference over other cues. Five-year-old, white, monolingual English speakers were presented with photographs of children, half of whom were white and half were black. When asked with whom they would be friends, the participants selected the photographs of white children, suggesting that they are using visual cues of race as an indicator of in-group preferences. However, when the photographs were paired with recordings of speech, the white faces were paired with foreign-accented voices and the black faces paired with native-accented voices. In this scenario, children were likely to choose photographs of black children with native-accented voices when asked with whom they would be friends. This suggests that children prioritise accent cues over visual cues of race when identifying others as in-group or not (Kinzler et al., 2009). The authors attribute this finding to accent

being more likely to be diverse than race in our evolutionary past. Taken together these studies support accent as a robust and common mechanism of establishing identifying information about transmitters.

4.3.2 Standard and non-standard accents determine a sociolinguistic construction of prestige

Within the CE literature, prestige is often conferred upon a person due to success or expertise in a particular domain; however, the prestige effect can be extended to all the traits of the individual (Henrich and Gil-White, 2001; Jiménez and Mesoudi, 2019b). For sociolinguists, accent-based prestige is often related to whether an accent is deemed a standard form or not, rather than being determined by success or expertise. Standard accents (e.g. RP) are often considered to carry prestige and are non-locality specific (Morales, Scott and Yorkston, 2012). This is because these accents develop through a process of standardisation, usually at the establishment level, and are therefore deemed an ideological aspiration (Coupland, 2003; Coupland and Bishop, 2007). As such there are two types of prestige within the sociolinguistic literature: 'overt prestige', where positive status is consciously ascribed to a variable due to determinable attributes such as 'niceness'; and 'covert prestige', where there is unconscious movement towards a particular variant (Meyerhoff, 2011). This relates to but is not to be confused with 'change from above' and 'change from below'. 'Change from above' relates to a conscious decision to imitate models of the highest status group, which is usually the planned, constructed standard dialect. 'Change from below' is like 'covert prestige' in that there is subconscious or unconscious orienting towards a target variant (Hawkey, 2016). Consciously orienting towards a standard accent could be considered both 'overt prestige' and 'change from above', but consciously adopting variants from non-standard accents could only be driven by 'overt prestige'. As such, it is possible for all accents, including non-standard and foreign accents, to be afforded prestigious status. In the next section I review literature that demonstrate how accents can index identity- and personality-based information.

4.3.2.1 Language Attitude Studies

Bayard et al. explored how participants in different locations reacted to New Zealand English, Australian English, standard North American English and RP accents of both women and men (2001). Participants from Australia, New Zealand and the United States were asked to listen to nine recordings (including a practice speech) representing all the accents being investigated. They were asked to identify qualities of the speakers including perceived ethnic information, and then asked to rate each speaker on a number of qualities, which clustered into power, solidarity, competence and status categories. For all groups of participants the male New Zealand accent was rated poorly across all categories. The female North American accent was rated highly by all groups across the majority of variables, often on par or higher than the RP accent. This suggests that the standard North American accent is gaining prestige on a global scale, which the researchers attribute to a greater Northern American presence in the media. It was also found that in the New Zealand group, participants rated New Zealand accents negatively across all qualities apart from those corresponding to solidarity, which was identified as a 'cultural cringe' effect. The recognition of a familiar accent is likely to be a cue of similarity and in-group bias, but this result suggests that we may be more neophilic and attuned to those displaying different qualities.

Whilst standard accents are often associated with prestige or high social value, regional or foreign accents tend to score highly across other attitudinal variables. In an early language attitude study looking at a variety of regional and foreign-accented English voices, Giles (1970) evaluated how different people viewed other accents based on their aesthetic, prestige and communicative content. Seventeen-year-olds from Somerset and South Wales were presented with different accents either vocally, conceptually or both, and were asked to rate accents on a Likert scale based on these qualities. When the accents were ranked it was clear that RP was heavily preferred across all contexts, whilst the Birmingham accent consistently ranks poorly. It is interesting to note that when an 'accent identical to your own' is presented conceptually, it scores highly in either first or second place for aesthetic, prestige and communicative content, despite Somerset and South Welsh scoring relatively poorly. This suggests that there is a preference for familiar

accents even if they are non-standard. However, this result also demonstrates difficulties in recognising our own accents or stigma felt by participants relating to the accents associated with where they live. This result is particularly important because it shows that we can use accent to recognise others within our groups, however, we may reinforce stereotypes associated with these accents. This, in turn, suggests that our perception of what accent can index should be grounded in terms of relevance if we are to use accent to signify group identity.

Almost 35 years later Coupland and Bishop broadly replicated these results, suggesting that attitudes towards accents in the UK have not greatly changed in a generation (Coupland and Bishop, 2007). The BBC Voices project was set up to further the survey of English dialects and asked people to record and send in examples of their dialect to see the diversity of current English spoken in the UK. This survey (n=5010) also contained attitudinal questions looking at pleasantness and prestige of 34 different accents. Standard accents and accents 'identical to one's own' were again rated most favourable for both social attractiveness and prestige, whilst Birmingham, Black Country and Asian accents were the least prestigious or socially attractive. The sample is slightly skewed with ages 25-64 years overrepresented. Those who participated in the studies in the 1970s are of the age where they fall into the group that is overrepresented so this may suggest that these attitudes are specific to a generation.

Children also evaluate speakers' personalities and qualities based on their accents. Kinzler and DeJesus' (2013) work on the attitudes of children towards differently accented people within the United States showed that stereotype recognition is developed in older (9-10 year old) children. Carried out in Illinois and Tennessee to represent northern and southern states, the authors found that five- and six-year-olds from Illinois would prefer to be friends with others from Illinois whilst those from Tennessee did not show any preference. They argued that Northern accents (of national news anchors and actors) are more exposed in media, which may have resulted in greater familiarity with this variety than expected on the part of the children from Tennessee. However, by age 9-10 children were able to differentiate whether they think speakers are more intelligent or in a position of authority, or friendlier. Northern-accented people were deemed more intelligent by children of this age group, while Southern-accented people were thought to be

kinder. However, children from Illinois also chose to remain friends with others with similar accents. This is despite considering Southern-accented people to be nicer, suggesting that familiarity and status may be a more important factor in deciding with whom to align themselves (Kinzler and DeJesus, 2013).

4.3.2.2 Applications of Language Attitude Studies

Accent perception has been studied in applied domains such as marketing (Tsalikis, Ortiz-Buonafina and LaTour, 1992; Laiwani, Lwin and Li, 2005; Lwin and Wee, 1999; Morales, Scott and Yorkston, 2012; Wang et al., 2013) and education (Gill, 1994; Rubin and Smith, 1990; Wang and Heuven, 2004). Eisenchlas and Tsurutani (2011) carried out a study in Australia which looked at how undergraduate students of languages and linguistics responded to different accented lecturers reading the same set piece of text. Students were asked to rate each speaker on a number of qualities broadly corresponding to competence, integrity and attractiveness. They were also asked to suggest what occupation they thought the speakers' held and indicate the speaker's native language. The Australian-English condition was rated highly for competence and integrity; however, the Spanish-accented speaker had a higher rating in all conditions. The Australian accent was deemed less attractive and Japanese the most attractive. Despite the Japanese accent having relatively low scores for competence and integrity, the majority of students suggested that this speaker had a high-status job, as was also suggested for the Spanish accent. Whilst almost all students were able to identify Australian English, less than half were able to identify the languages of the other speakers. Many students who were learning the native language of the speaker were unable to identify the correct accent. This suggests that one does not need to have heard a particular accent but rather exposure to other languages in general may create positive responses to foreign accented speakers. The negative response on attractiveness of the Australian accent might be another cultural cringe effect (Bayard et al., 2001). If the cultural cringe effect is present across accent-based studies, it reinforces the need to ensure that accents chosen for different locations are locally calibrated. Furthermore, in a more globally connected environment, researchers must be aware of the changing social

value of different accents and address this as part of their research to ensure that results are interpreted accurately and attributed to appropriate variables.

Accent studies in marketing have focussed on favourability and memorability of different accents and dialects in audio advertisements. The basic premise is that advertisements using prestigious accents should be more successful as the associated prestige would be conferred to the products they were advertising; however, this has to be locally calibrated to be effective, which has not always been the case. Morales et al. (2012) carried out research in the United States investigating how accents associated with high and low prestige affected favourability of the product and memorability of the advertisement. Using a standard British accent as a high prestige accent and a non-standard Southern US accent to represent low prestige, Morales et al. carried out a number of investigations to determine how prestige and familiarity carried different benefits in terms of favourability of product and ease of recall for consumers.

Accents were calibrated for the task as participants rated the standard accent higher for prestige than non-standard accents and stated that the non-standard accent used was more familiar. Participants were also asked to listen to radio adverts using these two accents for two hotels appropriate for different activities. Participants evaluated the hotels and were asked to recall important details such as the name of the hotel, which was the same across all conditions. It was found that when a standard British accent was used, perception of the hotel was more favourable, however recall of the name of the hotel was significantly lower. This study found that participants would actively confer perceptions about accents to the products themselves, and, as a consequence, participants rated products unfavourably when advertised with non-standard accents (Morales et al, 2012). These results have major implications for marketing as it suggests that it is better to use standard accents in advertisements as they bestow prestige on the product and are rated more favourably, however, at the cost of being potentially less memorable.

Using a standard British English accent and the local Singaporean English (Singlish) accent to represent the non-standard accent, Laiwani and colleagues (2005) hypothesised that participants would perceive the speaker to be more credible if they had a British accent for a product created abroad and if a Singlish accent was used for products of local origin. However, a standard British accent was

rated higher across professionalism, affinity and reliability in all advertisements irrespective of origin of product, and the attitudes towards the brands were more positive. Conversely, the Singlish accented advertisements received greater attention, as measured by participants' responses to three items regarding interest and attention paid to the advertisement on a seven-point Likert-type scale. This suggests that, whilst a standard British accent may help products receive greater favour, consumers are more likely to pay attention to and remember an advertisement utilising local accents.

Together these studies demonstrate that accent can be used as a reliable cue of social factors including prestige. CE studies have previously used attention- (Atkisson, Mesoudi and O'Brien, 2012; Chudek et al., 2012; Henrich and Gil-White, 2001) or success-based (Baldini, 2012; Mesoudi, 2008) measures of prestige, which rely upon previous knowledge of what is deemed prestigious; or artificial manipulation to determine prestige. As demonstrated above, accent may provide a robust measure of prestige when locally calibrated, and is evidenced as a source of social information across cultures. Furthermore, this suggests that if accent is not addressed, it may be a confounding factor in all other studies of oral transmission. Here, we investigate the differential prestige of locally calibrated accents in the UK and US to be used as a cue of prestige for a transmission study (Chapter 5).

The aims of this paper are twofold: a) to replicate previous language attitude studies to determine whether attitudes towards different accents of English are both stable and widely shared, and therefore, can act as a reliable source of social information bias; and b) to specifically investigate how those accents differ in prestige. Here, we present results from a language attitude survey where we presented a range of locally calibrated standard and nonstandard accents to participants. We expect that 1) accents are rated differentially on measures of prestige; 2) standard accents will have greater prestige; and 3) non-standard accents will be perceived as less prestigious.

4.4 Materials and Methods

4.4.1 Participants

Participants in this task were recruited through the online platforms Amazon Mechanical Turk and Turk Prime, and Prolific Academic for US (n = 152) and UK (n = 142) samples respectively. Ethical approval was obtained from the University of Bristol Faculty of Arts Research Ethics Committee and Colorado State University Institutional Review Board, and participants were compensated for their time at rates above local minimum wage based on the time taken to complete the tasks.

4.4.2 Protocol

Participants answered a short demographic questionnaire and were presented with ten recordings of differently-accented speakers reading the *Comma Gets a Cure* passage ((Honorof, McCullough and Somerville, 2000), see Appendix A), a piece of text specifically written to discriminate between accents of English (see below). Of the 10 recordings, eight were from the country in which the participant was based, and the other two were from the other country, providing a robustness check and a measure of how widespread accent perceptions are. We only presented four accents to both sets of participants instead of the full catalogue of accents to reduce time taken to complete the study and to limit participant's loss of engagement with the task. Based on previous literature (Coupland and Bishop, 2007; Giles, 1970; Labov, Ash and Boberg, 2005; Shackleton, 2007) we chose accents that represented both high and low prestige across both the participants' own and other country. All speakers recited the same passage, so we presented only the first paragraph of the passage (approximately 30 seconds) to shorten the overall length of the study and to ensure that participants' engagement with the task was not compromised due to attention loss. Participants were instructed that they would hear the same passage in each recording and were not instructed to pay attention to content, allowing them to focus on the voices. As they listened to each recording, participants rated the speakers on a six-point Likert-type scale for 24 attitudinal variables.

4.4.3 Recordings

All but two recordings were sourced from the International Dialects of English Archive (IDEA: https://www.dialectsarchive.com/). This archive stores over one thousand samples of speech in English comprising recordings and interviews. For many of these recordings, phonetic transcripts are provided, as well as a detailed history of where the speakers have lived. We used recordings of white, male speakers between the ages of 31 and 59 years (mean age = 47.7 years), as a previous unpublished pilot study found that younger, female voices were deemed less prestigious. Due to issues with the available IDEA samples we recorded additional speakers with Colorado and Welsh accents who fit the demographic category.

Table 4.1. Accents used from the UK and US. Accents listed in bold were presented to both populations.

	UK Recordings	*US Recordings*
Standard	**Received Pronunciation** SE England	**Colorado (West, urban)** Wyoming (West, rural) Oklahoma (Midland)
Non-standard	Ireland **NW England** Scotland SW England Wales Yorkshire and the Humber	Illinois (Inland North) New York City **North Carolina (Inland South, blue collar)** North Carolina (Inland South, white collar) Pennsylvania (Mid-Atlantic)

Recordings from IDEA are categorised by location: the US recordings are indexed by state, and the UK material are by broad geographic area. The recordings chosen were cross-referenced with dialect areas as defined by Labov et al. (2005) for US accents and Shackleton (2007) for UK accents, providing both regional coverage and accent variation. As Labov et al. (2005) classify six regional accent areas in the US (North, West, New England, New York City and Mid-Atlantic, Midland and South), two recordings representing the West and Inland South accent are included from speakers who differ in occupation. We did not test New England accents due to lack of quality recordings available for speakers with the desired demographic

characteristics. The accents presented to both UK and US participants were representative of standard (UK: Received Pronunciation and Southeast English accents; US: 'General American' [West and Midland] accents) and non-standard variants (Cheshire, 1991; Trudgill and Hannah, 2008) (see Table 1).

Comma Gets a Cure is a passage containing terms from J.C. Wells' lexical set (1982). The first paragraph included the following words, which are used to highlight phonological differences between accents: NURSE, HAPPY, START, NORTH, SQUARE, FACE, DRESS, FLEECE, and KIT. The variation in vowel space used for these words is listed for RP and General American in this lexical set (Evans and Iverson, 2004), and can be diagnostic for different regional accents (Evans and Iverson, 2004). As such we would expect these recordings would demonstrate diversity for participants to either identify or make judgments based on different accents.

4.4.4. Attitudinal Variables

Table 4.2.Attitudinal variables evaluated by participants. Highlighted terms are included in the Position-Reputation-Information scale of prestige (Berl et al., 2019). Status, solidarity and dynamism dimensions taken from Fuertes et al. (2012).

Unclassified	Status	Solidarity	Dynamism
prestigious	high social status	kind	hardworking
powerful	wealthy	good natured	friendly
reputable	intelligent		aggressive
respected	educated		active
successful	ambitious		confident
driven	talented		
skilled	clear		
warm			
comforting			
enthusiastic			

Our attitudinal variables were selected based on the most common terms from previous language attitude studies across domains of status, solidarity and dynamism (Fuertes et al., 2012). We also designed this experiment to test the

Position-Reputation-Information (PRI) scale of individual prestige, the results of which we have presented and discussed in a separate paper (Berl et al., 2019) (see Table 2). We include PRI terms to capture aspects of prestige not previously considered in other language attitude studies (Brown, Giles and Thakerar, 1985; Callan and Gallois, 1987; Fuertes et al., 2012; Giles, 1970; Gill, 1994; Levin, Giles and Garrett, 1994).

We asked participants to rate accents for the terms in Table 2 where 1 was 'strongly agree' and 7 was 'strongly disagree'. We asked participants to rate accents for the terms in Table 2 where 1 was 'strongly agree' and 7 was 'strongly disagree'. The scale was reversed for some of the terms to ensure that participants' attention was held and to reduce response bias (Schriesheim and Hill, 1981). Negative forms of the intelligent, ambitious and kind were used by supplying 'un-' as a prefix. We randomised the order in which we asked participants about these terms for each accent recording. An additional artificial speech recording was included with instructions to rate all terms beginning with consonants a '7' and all terms beginning with vowel a '1' as an attention check.

4.4.5 Data Analysis

We prepared and analysed data using the *stringr*, *reshape*, *FactoMineR* and *base* R packages. Participants vary in how they use the Likert scale, so we calculated z-scores so that responses were comparable to the mean. Although we included the term 'prestigious', previous research shows that 'prestige' is multifaceted and participants operationalise various definitions of prestige in experimental contexts (Berl et al., 2019). A Principal Component Analysis (PCA) was run to capture the majority of the data with a reduced number of variables. The PCA was conducted in the *FactoMineR* and *factoextra* packages, Welch's ANOVA was carried out using one way tests with all other statistical tests carried out in the *base R* package. Boxplots were created using *ggplot2*.

4.5 Results

To consolidate the number of variables, we ran a Principal Component Analysis (PCA) on all respondents' data for their evaluative ratings on the different attitude variables (e.g. friendly, skilled) across accents. We found that attitudinal variables cluster with five components having eigenvalues greater than 1, which accounted for 51.59% of the variation. Component 1 accounts for 22.67% of variance relate to prestige or status domains. Component 2 accounts for 11.16% of variance and corresponds to friendliness, or terms that we would expect in line with the solidarity and dynamism domains (Figure 4.1). Components 3 (5.70% of variance), 4 (5.29% of variance), and 5 (3.78% of variance) are in line with the position (hierarchical status), reputation and information (education) categories of prestige from the PRI scale (Berl et al., forthcoming; see Appendix B).

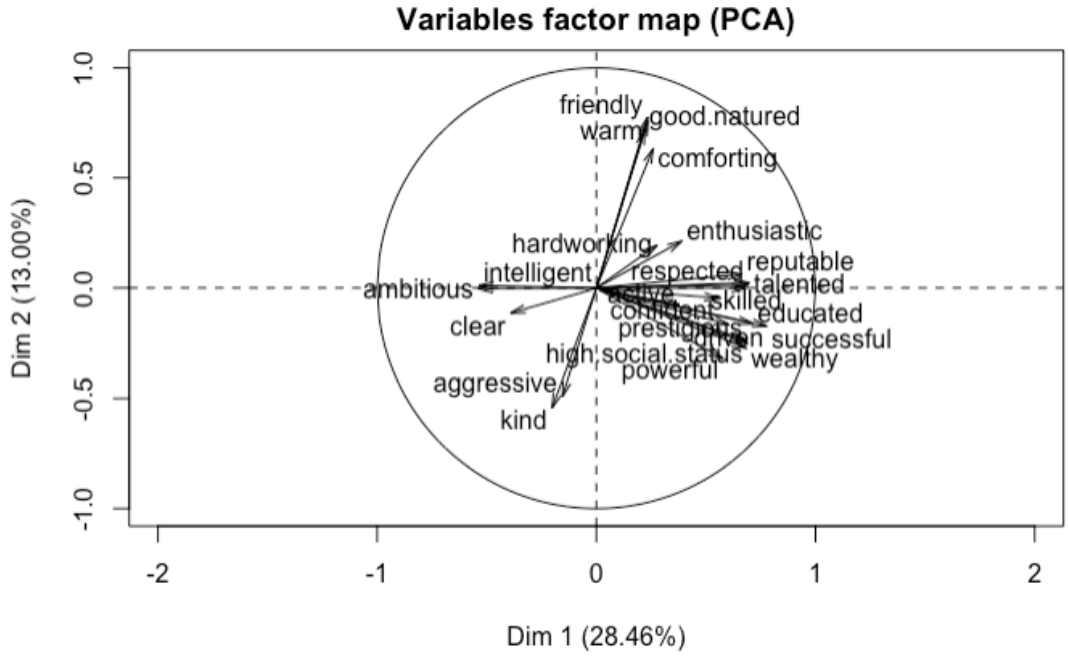


Figure 4.1. Principal Components Analysis (PCA) showing attitudinal variables along Prestige (Dim 1) and Friendliness (Dim 2) dimensions.

Attitudinal measures of 'ambitious' (-0.54) and 'clear' (-0.39) correlated negatively with the prestige dimension, a result which contradicts previous research arguing that both terms are status driven (Fuertes et al., 2012). In support of this finding, in our other work both of these terms also dropped out of the PRI scale of individual

prestige due to clustering with other domains ('clear') or low salience for prestige with participants ('ambitious') (Berl et al., 2019). These results support the omission of these terms from status or prestige domains. However, the negative relationship between 'kind' and the friendliness dimension is also unexpected. However, as 'kind' was one of the reversed terms and presented to participants in the negative form 'unkind', this may be due to participants losing attention. We found that participants were less inclined to rate reversed terms at extreme parts of the scale.

Assumptions for normality and homogeny of variance were not met for one-way ANOVAs for both prestige and friendliness; therefore, we deemed sample size sufficient for Welch's ANOVA. For the prestige dimension (Figure 4.2), we found a statistically significant difference between accents ($F(15) = 134.84$, $p < 0.001$). Pairwise comparisons using Wilcoxon rank sum tests using the Benjamini and Hochberg (BH) p-value adjustment method showed that there were significant differences between participant's evaluations of prestige for the accents emboldened in Table 4.3. Differences between standard and non-standard accents are highlighted in Table 4.3. These results demonstrate variance in responses to accent prestige and are consistent with the hypothesis that standard accents (e.g. Received Pronunciation and General American accents) are rated more favourably for prestige over non-standard accents. However, not all pairwise comparisons of standard and non-standard accents are significant for prestige and friendliness. This might suggest that there is a continuum of standardness, rather than the binary model. However, as there is variation within accent as well as between accents, it is difficult to typify what the standard accent is for each location. Had we collected data as a binary (i.e. prestigious or not prestigious) rather than on a Likert scale we may find greater distinction in responses as it has been shown that participants may avoid 'socially unacceptable' responses by selecting more neutral options on a Likert scale (Garland, 1991). Participants rated the Welsh English accent favourably for prestige despite previous studies concluding that Welsh English is usually ranked as middling for prestige and social attractiveness (Bishop, Coupland and Garrett, 2005; Coupland and Bishop, 2007; Giles, 1970), but, as this was recorded recently by the authors, this may be due to better sound quality.

For the friendliness dimension (Figure 4.3), Welch's ANOVA ($H(15) = 44.521$, $p < 0.001$) determined there was a statistically significant difference

between groups. Pairwise comparisons using Wilcoxon rank sum tests (using BH p-value adjustment method) showed that were significant differences between participant's evaluations of friendliness for the accents emboldened in Table 4.4. Differences between standard and non-standard accents are highlighted in Table 4.4.

Here, we find that Southeast England English is rated most highly for prestige by UK participants but ranked considerably lower for friendliness. Regional accents from the West of England are considered favourably for friendliness. US participants rated Mid-Atlantic and Western accents (consistent with General American accents) highly for prestige but rated RP as the most prestigious accent. The Inland South accent was rated low for prestige but highly for friendliness. These findings hold when we use either the prestige and friendliness dimensions or the 'prestigious' and 'friendly' variables for analysis (Figures 4.2 and 4.3).

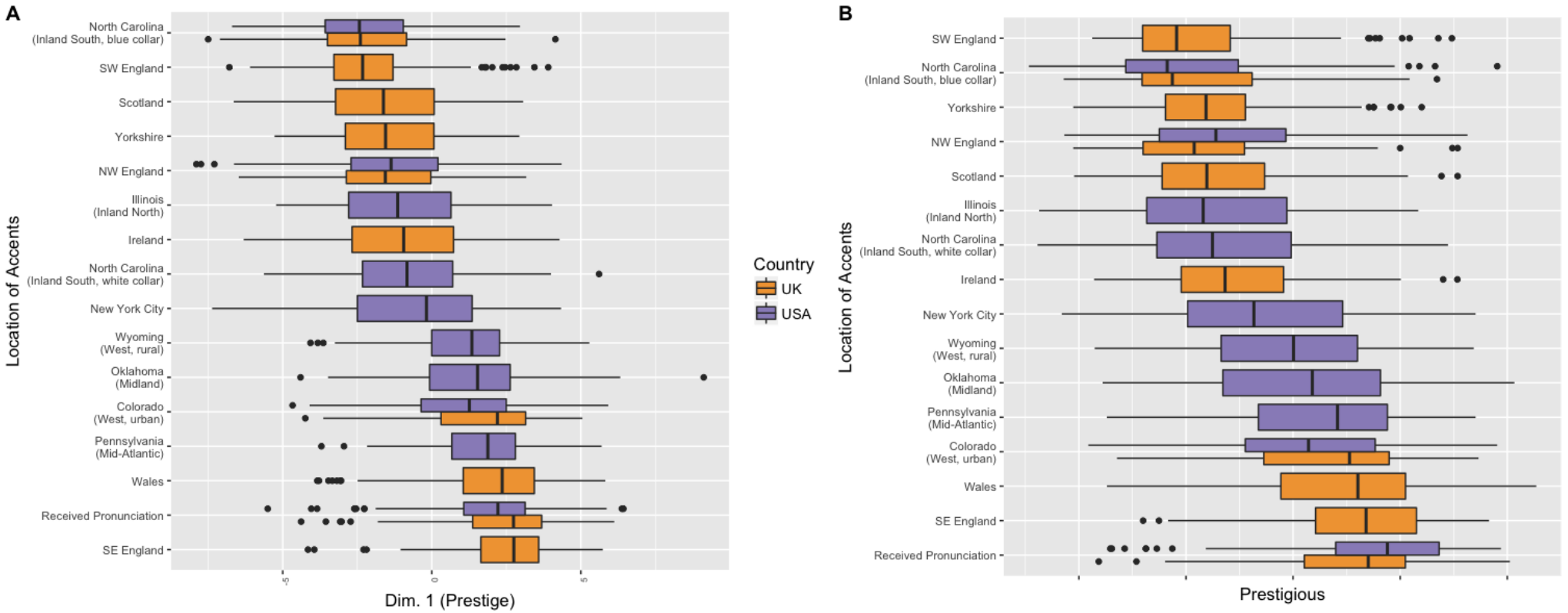


Figure 4.2 Perceived prestige of regional accents of English. Each boxplot represents the distribution of responses of participant scores for A) Dim. 1 (Prestige) and B) the variable 'prestigious' where 0 is neutral after standardisation. The hinges correspond to the first and third quantiles and the central line represents the median. UK participants rated accents with orange boxplots and US participants rated accents with purple boxplots. We present participants with accents from their own country of residency with the exception of accents with two boxplots. These accents were presented to participants in both locations.

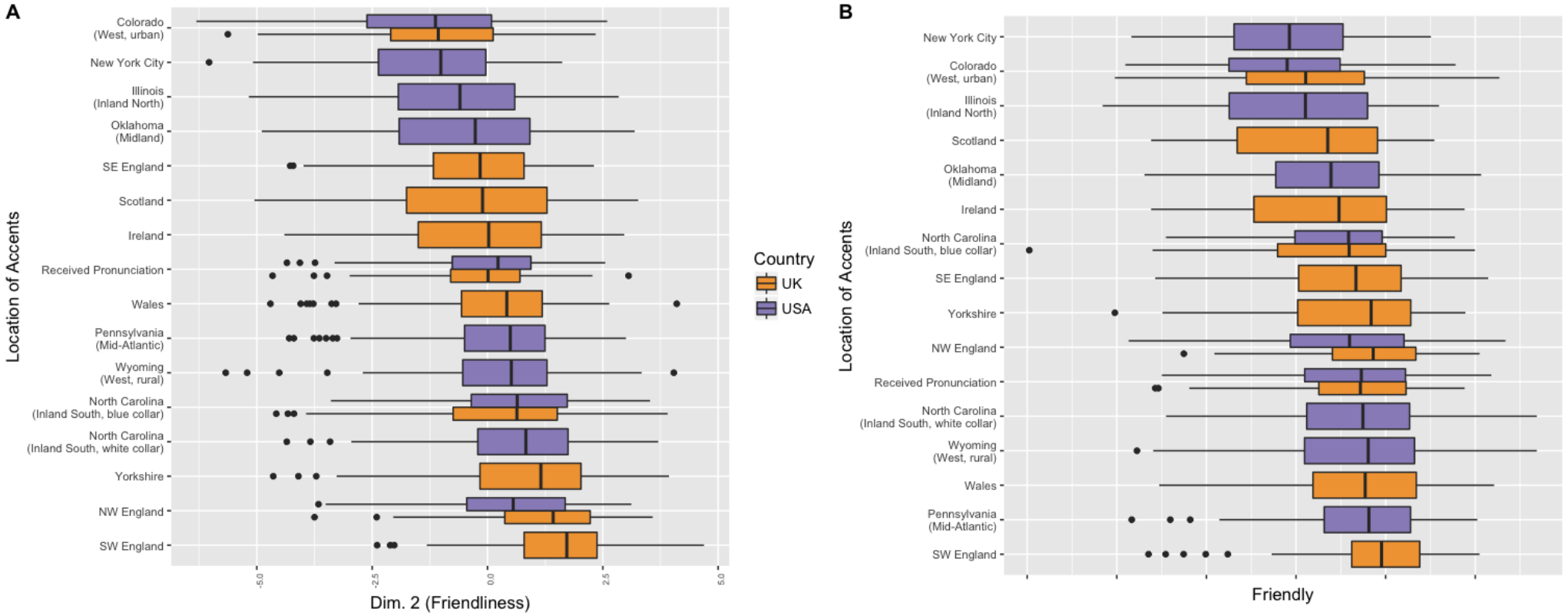


Figure 4.3 Perceived friendly of regional accents of English. Each boxplot represents the distribution of responses of participant scores for A) Dim. 2 (Friendliness) and B) the variable 'friendly' where 0 is neutral after standardisation. The hinges correspond to the first and third quantiles and the central line represents the median. UK participants rated accents with orange boxplots and US participants rated accents with purple boxplots. We present participants with accents from their own country of residency with the exception of accents with two boxplots. These accents were presented to participants in both locations.

Table 4.3. Significance of pairwise comparisons of prestige (Dim 1) between accents using Wilcoxon rank sum tests. Emboldened cells are significant where p<0.05. Highlighted cells show a difference between a standard and non-standard accent.

	SE England	RP	Wales	Pennsylvania (Mid-Atlantic)	Colorado (West, urban)	Oklahoma (Midland)	Wyoming (West, rural)	New York City	North Carolina (Inland South, white collar)	Ireland	Illinois (Inland North)	NW England	Yorkshire	Scotland	SW England
RP	0.10930														
Wales	**0.02444**	0.35640													
Pennsylvania (Mid-Atlantic)	**5.9e-06**	**0.00152**	0.06685												
Colorado (West, urban)	**3.2e-09**	**3.1e-07**	**0.00150**	0.11818											
Oklahoma (Midland)	**3.0e-09**	**4.5e-07**	**0.00059**	**0.03532**	0.51432										
Wyoming (West, rural)	**1.3e-11**	**2.2e-09**	**2.7e-05**	**0.00281**	0.16030	0.47400									
New York City	**< 2e-16**	**< 2e-16**	**< 2e-16**	**1.3e-15**	**6.0e-13**	**2.1e-09**	**2.9e-08**								
North Carolina (Inland South, white collar)	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**5.3e-15**	**1.0e-13**	0.15111							
Ireland	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**1.3e-14**	**2.3e-13**	0.12588	0.86321						
Illinois (Inland North)	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**1.2e-15**	**0.03340**	0.36221	0.48089					
NW England	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**0.00041**	**0.03340**	0.06685	0.31009				
Yorkshire	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**0.00086**	**0.03029**	0.06265	0.26551	0.82757			
Scotland	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**0.00016**	**0.00983**	**0.01626**	**0.09527**	0.37073	0.55638		
SW England	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**7.6e-09**	**1.6e-07**	**1.3e-06**	**5.4e-05**	**0.00013**	**0.00117**	**0.01751**	
North Carolina (Inland South, blue collar)	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**< 2e-16**	**1.2e-11**	**1.0e-09**	**1.5e-08**	**1.1e-06**	**2.2e-06**	**0.00015**	**0.00443**	0.82757

Table 4.4. Significance of pairwise comparisons of friendliness (Dim 2) between accents using Wilcoxon rank sum tests. Emboldened cells are significant where p<0.05. Highlighted cells show a difference between a standard and non-standard accent.

	SE England	RP	Wales	Pennsylvania (Mid-Atlantic)	Colorado (West, urban)	Oklahoma (Midland)	Wyoming (West, rural)	New York City	North Carolina (Inland South, white collar)	Ireland	Illinois (Inland North)	NW England	Yorkshire	Scotland	SW England
RP	0.08352														
Wales	**0.00336**	0.06344													
Pennsylvania (Mid-Atlantic)	**0.00041**	**0.01433**	0.62367												
Colorado (West, urban)	**5.2e-07**	**< 2e-16**	**8.2e-16**	**< 2e-16**											
Oklahoma (Midland)	0.36036	**0.00903**	**0.00041**	**6.7e-05**	**0.00041**										
Wyoming (West, rural)	**0.00067**	**0.01674**	0.63308	0.94824	**< 2e-16**	**8.0e-05**									
New York City	**5.2e-06**	**7.6e-13**	**3.8e-13**	**1.1e-14**	0.87515	**0.00166**	**1.6e-14**								
North rolina (Inland South, white collar)	**1.3e-07**	**2.0e-06**	**0.01433**	**0.04169**	**< 2e-16**	**1.7e-08**	**0.04900**	**< 2e-16**							
Ireland	0.51628	0.53118	0.06344	**0.02018**	**6.2e-08**	0.10615	**0.02201**	**1.5e-06**	**3.9e-05**						
Illinois (Inland North)	0.08394	**0.00028**	**1.5e-05**	**1.5e-06**	**0.00556**	0.54059	**1.9e-06**	**0.01955**	**2.7e-10**	**0.02907**					
NW England	**1.8e-12**	**1.1e-12**	**4.0e-05**	**0.00026**	**< 2e-16**	**7.9e-14**	**0.00073**	**< 2e-16**	0.21817	**1.0e-08**	**6.8e-16**				
Yorkshire	**3.9e-09**	**8.2e-09**	**0.00037**	**0.00120**	**< 2e-16**	**2.2e-10**	**0.00226**	**< 2e-16**	0.21244	**8.5e-07**	**1.1e-11**	0.79038			
Scotland	0.54704	0.46537	0.07158	**0.02042**	**4.4e-07**	0.13680	**0.01890**	**5.6e-06**	**6.5e-05**	0.94510	**0.04069**	**1.8e-08**	**1.3e-06**		
SW England	**< 2e-16**	**< 2e-16**	**7.7e-14**	**7.9e-13**	**< 2e-16**	**< 2e-16**	**1.2e-11**	**< 2e-16**	**6.1e-07**	**< 2e-16**	**< 2e-16**	**1.2e-05**	**0.00082**	**7.7e-16**	
North Carolina (Inland South, blue collar)	**3.7e-06**	**6.5e-05**	0.11777	0.28731	**< 2e-16**	**1.2e-07**	0.32171	**< 2e-16**	0.26113	**0.00045**	**1.6e-09**	**0.00588**	**0.01847**	**0.00054**	**6.1e-11**

4.6 Discussion

4.6.1 Accents can be used to index social characteristics

Our results show that participants are able to make discriminatory judgments about speakers based on accent alone. In the absence of any other information and provided with the same content, participants differentially rated participants across many attitudinal variables. The results of our PCA suggest that prestige and friendliness may be specifically relevant categories that can be manifested through accent. These domains also broadly correspond to prestige and familiarity biases in the CE literature, which suggests that accent might be operationalised as a cue for these factors in CE experiments.

4.6.2 Accents demonstrate differential prestige

For British and American English speakers, accents show differential prestige (Figure 4.2). The General American cluster of accents (West/Midlands) and RP, all standard forms of English, were rated favourably for prestige by participants across both locations. This finding contributes to a body of research suggesting that we associate prestige with standard varieties (Brown, Giles and Thakerar, 1985; Coupland, 2003; Coupland and Bishop, 2007; Giles, 1971, 1973; Giles and Sassoon, 1983; Milroy, 2007; Milroy and Milroy, 1999). However, participants in both countries rated RP highest for prestige, implying that the prestige of this particular variety is stable and widespread. This result has been found elsewhere, which is likely to be an artefact of the British colonial past (Stewart, Bouchard Ryan and Giles, 1985). General American accents were also rated highly so our results are unlikely to be a case of cultural cringe, whereby participants are less favourable towards accents similar to their own (Bayard et al., 2001; Eisenchlas and Tsurutani, 2011; Pickles, 2011). We might expect that some level of in-group association is necessary for prestige to be relevant, however, here we show that prestige can be afforded to out-group members. As US participants rated RP as having the highest prestige, this suggests that we cannot make assumptions about the relevancy of

accents and should be testing and locally calibrating the accents used in accent based studies.

4.6.3 Regional accents are perceived as friendlier

In line with previous studies (Coupland and Bishop, 2007; Giles, 1970; Kinzler and DeJesus, 2013), the top five friendliest accents (SW England, NW England, Yorkshire, North Carolina – blue collar, North Carolina – white collar) rated by our participants are regional/non-standard accents (see Figure 4.3). However, standard accents varied in their perceived friendliness. Prior research provides evidence to suggest that we associate stereotypes with location-specific accents (Boucher et al., 2013; Gluszek and Dovidio, 2010; Ladegaard and Sachdev, 2006), and so we may find this result because it is more difficult to reconcile both positive and negative stereotypes with generalised accents. However, standard accents may still be deployed as an outgroup when considering solidarity-related biases because they are usually non-geographically specific. In this case it is difficult to form a shared identity based on accent alone.

4.6.4 Prestigious accents are less likely to be considered friendly

In general, participants perceived location-specific non-standard accents as having lower prestige. Conversely, of the four accents presented to both listeners in both locations, participants perceived those deemed as having lower prestige as being friendlier, which may suggest that a trade-off exists between being deemed prestigious or friendly (Coupland and Bishop, 2007; Kinzler and DeJesus, 2013; Laiwani, Lwin and Li, 2005; Morales, Scott and Yorkston, 2012; Stewart, Bouchard Ryan and Giles, 1985).

However, if we are to posit that non-standard regional accents are perceived as friendlier, RP might be considered a special case. Participants did not rate RP as unfriendly, despite its high prestige score, as expected for both UK and US participants. This outcome may be because RP has often been associated with the 'Queen's English,' which has variable connotations depending on the listener. For example, other language attitude surveys found older individuals and participants in

Southeast England hold positive attitudes towards 'Queen's English', but this accent is deemed socially unattractive in Celtic fringe regions such as Northern Ireland, Scotland and Wales, potentially a consequence of socio-political context (Bishop, Coupland and Garrett, 2005; Coupland and Bishop, 2007). As such RP may index a specific socio-political context that may be deemed socially attractive internationally.

4.6.5 Accents can be used as a robust cue for prestige in CE studies

Across both populations, participants' responses to the relevant standard and regional/non-standard accents were similar. Participants were also able to identify the accents from the alternative country as high or low prestige, and evaluated these accents in line with participants from the other country. This is an interesting finding because, although we might expect associations with accent to be based on familiarity, our results suggest that these two populations share attitudes toward accent notwithstanding group affiliation or lack thereof. This may be partially due to working with Global North populations only, who may have greater exposure to multiple accents of English in media. Nevertheless, for the populations studied, our results replicate previous language attitude surveys (Bishop, Coupland and Garrett, 2005; Boucher et al., 2013; Bresnahan et al., 2002; Giles, 1970; Kinzler and DeJesus, 2013; Ladegaard and Sachdev, 2006), suggesting that these attitudes are stable and widespread, and therefore can be effectively deployed as a cue for prestige, and potentially other social information.

Accent has not previously been used in social transmission experiments, and prestige has often been established through attentional cues or deference (Atkisson, Mesoudi and O'Brien, 2012; Chudek et al., 2012; Henrich and Gil-White, 2001; Jiménez and Mesoudi, 2019b). However, in any transmission event that relies upon the use of speech or verbal cues, accent prestige may be an additional confound that is unaccounted for. We suggest that researchers at the very least should consider the effects on their studies if accent is a carrier of social information cues.

There are other ways to operationalise prestige such as telling individuals that the model has some form of expertise or suggesting that the model is particularly wealthy, however this involves intervention on the part of the

experimenter. Accent provides a robust measure of prestige based on individual perception, rather than cues from others. Although third party cues for prestige can be easily manipulated in a laboratory setting, people make judgements everyday about other individuals without additional knowledge. The variance in prestige across accents of English shows that accent can be used as an indicator of prestige in the absence of other prestige information, and, thus, could be used as a broadly-shared cue of prestige bias. Aspects of language (e.g. accent, prosody, gesture etc) beyond propositional content have been underexplored by social learning and cultural evolution researchers and we hope our results show that there is much to learn. Finally, further research to examine prestige evaluation effects in languages other than English would be valuable in establishing these phenomena more generally.

Based on these results, in the next chapter we use accent to manipulate prestige bias. We use RP as a locally calibrated high prestige accent, and both Inland South (North Carolina) and South West English as low prestige accents for the US and UK respectively in a single-shot transmission study to investigate whether accent prestige influences the recollection of information.

Chapter 5: Prestige and Content Biases Shape Cultural Transmission[2]

5.1 Abstract

Context-based cultural transmission biases such as prestige are thought to have been a primary driver in shaping the dynamics of cultural evolution and behaviour change. However, few empirical studies have measured the importance of prestige relative to other effects such as those of content biases, which are inherent to the information being transmitted. Here, we report the findings of an experimental study of cultural transmission designed to compare the simultaneous effects of a high- or low-prestige model with the presence of content containing social, survival, emotional, moral, rational, and counterintuitive information. We presented participants from the US (n = 100) and UK (n = 96) with recordings of artificial creation stories, which we constructed to have these types of content in frequencies comparable to stories from real societies. The artificial creation stories were read by individuals with locally calibrated high- or low-prestige regional accents of English, which we established as reliable proxies for prestige in prior studies. We then asked participants to verbally recall the stories and coded their responses on a propositional basis to determine which content types were recalled and under which prestige condition. Results from multimodel inference reveal that prestige is a significant factor in determining informational salience and recall, but that several

[2] This chapter is adapted from a manuscript for publication written in collaboration with Richard Berl (RB), Sean Roberts (SR), Michael Gavin (MG) and Fiona Jordan (FJ). AS, RB, MG and FJ conceived and designed the study. AS surveyed the ethnographic creation stories and coded these stories for biased content. AS and RB carried out propositional analysis for the artificially created stories and coded them for biased content. SR developed and implemented the experimental platform. RB collected the US data and AS collected the UK data. AS transcribed and coded the data. RB carried out the statistical analysis. AS and RB co-wrote the first draft of the manuscript. AS, RB, MG and FJ edited the manuscript with comments from SR. This chapter also includes additional material (Study 2) on pages 119-123 that is not included in the manuscript that is intended to be submitted for publication.

content biases, including social, survival, negative emotional, and biological counterintuitive information, are significantly more influential.

Further, we find that prestige is utilised as a conditional strategy in determining the transmission of unbiased information when no content cues are available. We demonstrate that no single bias fully explains variation in recall in the transmission of narratives, but that content biases serve a vital and underappreciated role in realistic transmission settings where multiple biases are present simultaneously. This work presents a novel experimental framework that has implications for the experimental study of cultural transmission and for the application of cultural evolutionary theory to real-world problems, as well as emphasising the value of storytelling as a cross-culturally relevant model for cultural transmission.

5.2 Introduction

Storytelling is a powerful and universal tool that humans use to understand the world (Bruner, 1991, 2009), to preserve history and traditional knowledge (Vansina, 1985; Lejano, Tavares-Reager and Berkes, 2013), to educate (Cajete, 1994; Piquemal, 2003), to persuade (Chang, 2009; Delgadillo and Escalas, 2004), and to heal (White et al., 1990; Struthers, Eschiti and Patchell, 2004). Stories encode complex cultural and ecological information, and some have endured for at least 7,000 years (Nunn and Reid, 2016; da Silva and Tehrani, 2016), and possibly much longer (Tehrani and d'Huy, 2017). In addition, skilled storytelling may increase an individual's reproductive fitness (Scalise Sugiyama, 1996) and the degree to which they are a preferred cohabitant (Smith et al., 2017). Why stories are such an efficient vector for information transfer is still debated. However, the cultural evolution literature suggest that stories are successful due to biased transmission (Barrett and Nyhof, 2001; Bebbington et al., 2017; Heath, Bell and Sternberg, 2001; Mesoudi, Whiten and Dunbar, 2006; Stubbersfield, Tehrani and Flynn, 2015; Stubbersfield and Tehrani, 2013).

The extent to which cultural selection, by way of biased transmission, is the primary factor responsible for cultural change is a central and enduring debate within the field of cultural evolution(Henrich, Boyd and Richerson, 2008; Claidière,

Scott-Phillips and Sperber, 2014; Acerbi and Mesoudi, 2015; Morin, 2016b). Cultural selection theory argues that cultural diversity is largely shaped by direct and indirect cognitive biases that unconsciously drive the selection of cultural variants over successive transmission events (Cavalli-Sforza and Feldman, 1981; Boyd and Richerson, 1985; Henrich, 2001). Without some sort of biased selection, cultural learning is unlikely to be more advantageous than individual learning (Rogers, 1988; Enquist, Eriksson and Ghirlanda, 2007; Rendell, Fogarty and Laland, 2009). In this study, we provide a novel and realistic approach to studying cultural change through investigating the relative effects of an array of competing biases within the transmission of narrative stories. This framework allows us to gain a better understanding of the microevolutionary processes that have shaped and continue to shape human culture.

Despite the critical role that transmission biases appear to play in driving cultural evolution, critical gaps exist in our understanding of the relative strengths of these biases (Acerbi and Mesoudi, 2015; McElreath et al., 2008; Kendal et al., 2018; Jiménez and Mesoudi, 2019b). Although models have been used to study the effects of different biases together (Gong and Shuai, 2012; Tamariz et al., 2014), prior experimental studies have tended to focus on individual biases, although multiple biases are always simultaneously present (Heath, Bell and Sternberg, 2001; Atkisson, Mesoudi and O'Brien, 2012; Morgan et al., 2012; Stubbersfield, Tehrani and Flynn, 2015; Acerbi and Tehrani, 2018). Narratives are a domain where the presence of information that contains certain content biases—a class of cultural transmission biases known as 'direct' biases (Boyd and Richerson, 1985)—has also been shown to aid the transmission of information (Boyer and Ramble, 2001; Eriksson and Coultas, 2014; Mesoudi, Whiten and Dunbar, 2006; Nairne, Thompson and Pandeirada, 2007; Norenzayan and Atran, 2004).

Content biases influence transmission through some inherent properties of the variant itself that make it more appealing and memorable (Boyd and Richerson, 1985). These preferences can vary between individuals and across cultures, but some have been seen to be remarkably consistent (Barrett and Broesch, 2012). Here we conduct the first simultaneous test of the relative effects of the most frequently cited content biases from the cultural evolution literature. This includes content linked to the following types of information: *social*, either in the sense of everyday

basic social interaction or of 'gossip' about third parties (Mesoudi, Whiten and Dunbar, 2006; Stubbersfield, Tehrani and Flynn, 2015); *survival*, for fitness-relevant ecological situations (Stubbersfield, Tehrani and Flynn, 2015; Nairne, Thompson and Pandeirada, 2007; Otgaar and Smeets, 2010); *emotional*, that elicits strong positive or negative responses such as disgust (Heath, Bell and Sternberg, 2001; Eriksson and Coultas, 2014; Fessler, Pisor and Navarrete, 2014; Stubbersfield, Tehrani and Flynn, 2017); *moral*, regarding acceptable behaviour and social norms (Heath, Bell and Sternberg, 2001; Baumard and Boyer, 2013), which has not been previously studied explicitly using transmission experiments; *rational*, cause-and-effect connections (Glenn, 1980); and *counter-intuitive*, which defies ontological expectations in biological, physical, mental, and other domains (Boyer and Ramble, 2001; Barrett, 2008). Additionally, counterintuitive information can influence transmission in different ways: singly, counterintuitive elements can be more salient than other types of information (Boyer and Ramble, 2001); or a minority of counterintuitive elements can lead to a minimally counterintuitive ('MCI') bias that enhances overall recollection of a story (Norenzayan et al., 2006; Stubbersfield and Tehrani, 2013). Here we crafted narratives that resemble real-world creation stories in both form and biased content, which have been subject to many generations of transmission and transformation (Study 1).

Beyond the types of information included in a story, learners are also sensitive to the identity of the storyteller. These transmission biases are referred to as context-based biases, and include model-based or 'indirect' (Boyd and Richerson, 1985) biases such as prestige (Henrich and Gil-White, 2001), success (Mesoudi, 2008), and similarity (McElreath, Boyd and Richerson, 2003; Mahajan and Wynn, 2012), and frequency-dependent conformity and anti-conformity biases (Henrich and Boyd, 1998). In this study, we specifically examine prestige bias, which involves a preference to learn from individuals of high social position, reputation, and knowledge (Berl et al., forthcoming; see Appendix B). Prestige bias is one of the most commonly cited transmission biases (Jiménez and Mesoudi, 2019b), and has been referred to as one of the predominant forces in cultural change (Henrich and Gil-White, 2001; Henrich and Boyd, 2002; Henrich, Chudek and Boyd, 2015). However, the limited empirical work on prestige bias to date has shown mixed support regarding the extent to which prestige affects the adoption of particular variants or

behaviours (see Jiménez and Mesoudi, 2019b for a recent general review on the topic). For example, Atkisson et al. (2012), McGuigan (2013) find evidence to support prestige bias; Acerbi and Tehrani (2018), Chudek and colleagues (2016), Garfield et al. (2019) and Reyes-García and colleagues (2008) find little or no evidence to support prestige bias, and others find that usage of prestige bias may depend on age (Henrich and Broesch, 2011; Little et al., 2015).

We use regional accents of speech as a novel experimental cue for prestige information (Study 1). As has been established within the field of sociolinguistics (Labov, 1966; Giles, 1970; Bishop, Coupland and Garrett, 2005; Coupland and Bishop, 2007; Fuertes et al., 2012) and verified by two previous studies using accent in this context (Berl et al., forthcoming; see Appendix B and Chapter 4), accents are perceived as strong indicators of prestige. Accents are hard-to-fake signals (Cohen, 2012) and tend to be stable over time (Evans and Iverson, 2007; Sonderegger, Bane and Graff, 2017); because of this, some varieties become associated with desirable upper class membership and index membership in high-status groups (Giles, 1970; Kroch, 1978; Kahane, 1986). These perceptions of accent are consistent with how prestige is understood in cultural evolution studies and provide a methodological alternative to the traditional use of attention, gaze, or group consensus to represent prestige, which potentially suffer from a number of flaws (Morin, 2016b; Ohlsen, van Zoest and van Vugt, 2013; Barkow, 2014; Roberts, Palermo and Visser, 2019). We present stories aurally, and ask for oral recall, which employs an important mechanism for information transmission considering that many societies are non-literate.

Finally, we test whether language itself contains bias evoking information and whether this is transmitted between generations. The words we use hold emotional value (Bestgen, 1994; Kensinger and Corkin, 2003; see section 2.3.3) and may be used to scaffold retention. We test whether less prestigious voices, which are often perceived as friendlier (Coupland and Bishop, 2007; see chapter 4), are more likely to transmit more emotional stories despite the stories being identical across conditions. (Study 2).

Human biases are highly sensitive to the nature of the information we consume and to the identities of potential cultural models that hold that information. Here, we address multiple gaps in the literature by explicitly

quantifying learners' recall of multiple distinct types of content, transmitted by speakers with varying levels of prestige. By testing content and context biases together in the experimental transmission of a narrative, we can examine the relative effects of a large suite of biases— biases that theory suggests shape the spread of information and the evolution of human culture.

5.3 Study 1

5.3.1 Materials and Methods

5.3.1.1 Story Production

We selected creation stories, which often pertain to the origins of life, death, ecology, and human society, as the narrative form to be used for this study because they are rich in the types of content proposed to be relevant to cultural transmission. Furthermore, this was done to enhance the ecological validity of the transmission event, as creation stories are a familiar pattern cross-culturally for the transmission of knowledge, values, and meaning, and have each individually been subject to many generations of transmission and transformation.

We undertook a survey of creation stories using ethnographic data from the electronic Human Relations Area Files (eHRAF) World Cultures database (see Acknowledgements). We conducted the survey by searching for 'creation' (and its derivatives) or 'origin' within texts indexed under the 'mythology' subject code (#773). We performed the search in the Probability Sample Files (PSF) subset, which is a stratified random sample of 60 cultures, each representative of a different 'culture area'. Our search returned 100 story extracts from 35 cultures, and from this we selected 4 texts for analysis on the basis of appropriate length (~300-1000 words) and being written and shared by in-group authors (rather than foreign ethnographers). The stories selected belonged to the A·chik Mande (referred to in eHRAF as ('Garo'), Baganda ('Ganda'), Kainai ('Blackfoot'), and Kānaka Maoli ('Hawaiian')) peoples. We also included the Genesis creation story (from the ancient Israelites), as presented in the New Revised Standard Version Bible (Coogan et al., 2010, Gen. 1.1-2.3). We coded the resulting five ethnographic creation stories at the level of propositions (word clusters consisting of "a predicate plus a series of

ordered arguments" [Mesoudi, Whiten and Dunbar, 2006, p.411]) for the presence of social, survival, emotional, moral, rational, and counterintuitive content elements. Definitions of these biases as used for coding are listed in the Appendix C. We carried out propositional analysis under the protocol established by Turner and Greene (Turner and Greene, 1977).

For the experiments, we commissioned two written artificial creation stories by professional author Rachel Sheer, who had surveyed the sample of creation stories. We did this rather than using the ethnographic stories we sampled in order to avoid issues of cultural appropriation surrounding the use of stories from real societies, and to ensure that our participants would all be equally unfamiliar with the stories. Using artificially created stories, which are present in all experiments which use narratives as stimulus material, could have consequences as other tools that are used to scaffold storytelling may be omitted. However, poor recollection based on lack of scaffolding should not be targeted and we would expect that: a) biases will be more effective; or more likely b) unbiased and biased information should be forgotten with equal weight. As our primary aim was to investigate the effects of accent prestige and content, we required two comparable stories, and, therefore, any naturally evolved stories would require editing. The first story, 'Muki', explains how a rugged landscape and its varieties of life-forms were shaped by the actions of a child abandoned by its parents. The second story, 'Taka and Toro', describes two jealous seafaring siblings and their competition over the friendship of the people they created (see Appendix D for 'Muki' and 'Taka and Toro' stories). Over many iterations, we edited the texts of these artificial creation stories to ensure the proportions of each type of biased proposition in each story matched one another, and also fell within 90% confidence intervals of the proportions seen in the coded ethnographic creation stories (Table 5.1). To do this we rated each story at the sentence level for the presence of bias, and then refined these stories to remove sentences where appropriate to maintain a consistent narrative but similar numbers of biased events. We then coded both stories for propositions and biases at the proposition level. After eight iterations we refined both stories to be approximately 850 words (Muki 887, Taka and Toro 835) and 270 propositions (Muki 265, Taka and Toro 273) to avoid ceiling effects for recall and to be of roughly equal complexity. Readability scores for these artificial stories were roughly equivalent

and used simpler language than the ethnographic stories they were modelled after (Flesch-Kincaid grade level[3]: Muki 4.91, Taka and Toro 5.03, Ethnographic Mean 8.22 [90% CI: 6.42, 10.02]; Flesch reading ease[4]: Muki 84.5, Taka and Toro 81.9, Ethnographic Mean 71.24 [90% CI: 62.24, 80.24]). The final versions of the two artificial creation stories, along with lists of their propositions and coded biases, can be found in Appendices D and E.

Table 5.1. Number of biased instances in creation stories coded at sentence level controlling for length of story.

Content Bias	90% CI for ethnographic creation stories	Muki	Taka and Toro
Social (Basic)	[0.707, 4.748]	3.833	3.952
Social (Gossip)	[0.000, 1.326]	1.240	1.198
Survival	[1.152, 2.718]	2.480	2.635
Emotional (Positive)	[0.009, 1.088]	1.015	1.078
Emotional (Negative)	[0.000, 2.137]	1.804	1.796
Moral	[0.466, 1.679]	1.015	0.958
Rational	[1.269, 2.894]	2.255	2.515
Counterintuitive	[0.216, 0.583]	0.338	0.359

5.3.1.2 Recordings

We used language accent to index prestige, in line with findings from sociolinguistics (Giles, 1970; Fuertes et al., 2012; Garrett, 2007; Labov, 1964, 1972). Language

[3] The Flesch-Kincaid grade level score is a measure of readability of text whereby the output corresponds to a US grade level. The score is calculated by the formula:
$x = 0.39\left(\frac{total\ no.of\ words}{total\ no.of\ sentences}\right) + 11.8\left(\frac{total\ no.of\ syllables}{total\ no.of\ words}\right) - 15.59$

[4] The Flesch reading ease score provides a readability score where higher scores indicate that a narrative is easier to read (e.g. 70-80 ≈ 7th grade; 80-90 ≈ 6th grade). The score is calculated by the formula:
$x = 206.835 - 1.015\left(\frac{total\ no.of words}{total\ no.of sentences}\right) - 84.6\left(\frac{total\ no.of\ syllables}{total\ no.of\ words}\right)$

attitude studies have demonstrated that non-localised 'standard' accents are associated with high prestige (Giles, 1973; Milroy, 2007; Milroy and Milroy, 1999; Stewart, Ryan and Giles, 1985) based on ideological values (Coupland, 2003; Coupland and Bishop, 2007), although regional non-standard accents demonstrate differential prestige (Giles, 1970; Bishop, Coupland and Garrett, 2005; Coupland and Bishop, 2007; Giles, 1971). We recorded self-identified middle-aged white male speakers with high- and low-prestige accents calibrated for the participants' locations telling the two stories ('Muki' and 'Taka and Toro'). The high- and low-prestige accents were selected based on the results of a previous study (see Chapter 4). For both the UK and US participants, the high-prestige accent used was Received Pronunciation ('RP'). For the UK sample, the low-prestige accent was West Country, from South West England; and for the US sample, the low-prestige accent was Inland South, spanning the southern Appalachian, Ozark, and Ouachita mountain ranges. We edited the recordings to standardise for volume and length (5 min, 19 s).

For an independent assessment of accent prestige, we also recorded our speakers reading the first paragraph of the *Comma Gets a Cure* passage (see Appendix A). This passage contains words from Wells's lexical set, designed to highlight phonological variation between different accents of English (Wells, 1982). We presented these recordings (range 35 s to 39 s) to participants to confirm that their perceptions of the prestige of each speaker matched what was expected (see Experimental Protocol).

5.3.1.3 Participants

We recruited UK participants on the Prolific Academic platform (n = 96; 35 men, 61 women), and US participants on Amazon Mechanical Turk (n = 100; 46 men, 54 women) using TurkPrime (Litman, Robinson and Abberbock, 2017). UK participants' ages ranged from 18 to 84 years (M = 36.87, SD = 9.85) and US participants ranged from 20 to 73 years (M = 37.63 , SD = 11.61). Participants were eligible to take part in this study if they: had not taken part in any previous studies by the researchers; had taken part in and had successfully completed over 95% of at least 100 studies on Prolific Academic or over 98% of at least 5,000 tasks on Amazon Mechanical Turk; and were native English speakers.

We excluded data from 23 participants due to technical recording errors or external interference (e.g. a second person contributing to a story). We compensated participants for their time at rates above local minimum wages based upon the time taken to complete the tasks.

5.3.1.4 Experimental Protocol

The experiment was administered through a custom web browser application using the SurveyJS library (source code available in the state it was used for the experiment at: https://github.com/seannyD/StoryTransmission/tree/a8a1a995dd0ce000222435bf70741ec2df237b29). Participants were directed from their respective recruitment platforms to the web application on University of Bristol servers. Participants first selected their location, which determined which of the locally-calibrated accent recordings they would hear. Participants were instructed to listen once to a recording of the first artificial creation story and were told that they would be asked to recall the story in as much detail as possible.

After listening to a creation story, participants took part in a working memory distraction task based on the Visual Spatial Learning Test (Malec, Ivnik and Hinkeldey, 1991). This task involved playing three rounds of a game where participants had to recall symbols and their positions on a grid (see Figure 5.1). For the symbols, we used the 9 most dissimilar characters from the 'BACS-1' artificial character set (Vidal, Content and Chetail, 2017). This distraction task took approximately five minutes to complete and provided a measure of unbiased working memory, which we calculated as the number of cards placed on the grid that matched the positions displayed (regardless of the symbol), plus the number of cards placed on the grid that matched both the positions and symbols displayed, averaged across all trials (equivalent to the Position Learning Index, or 'PLI' score, of Malec, Ivnik and Hinkeldey, 1991).

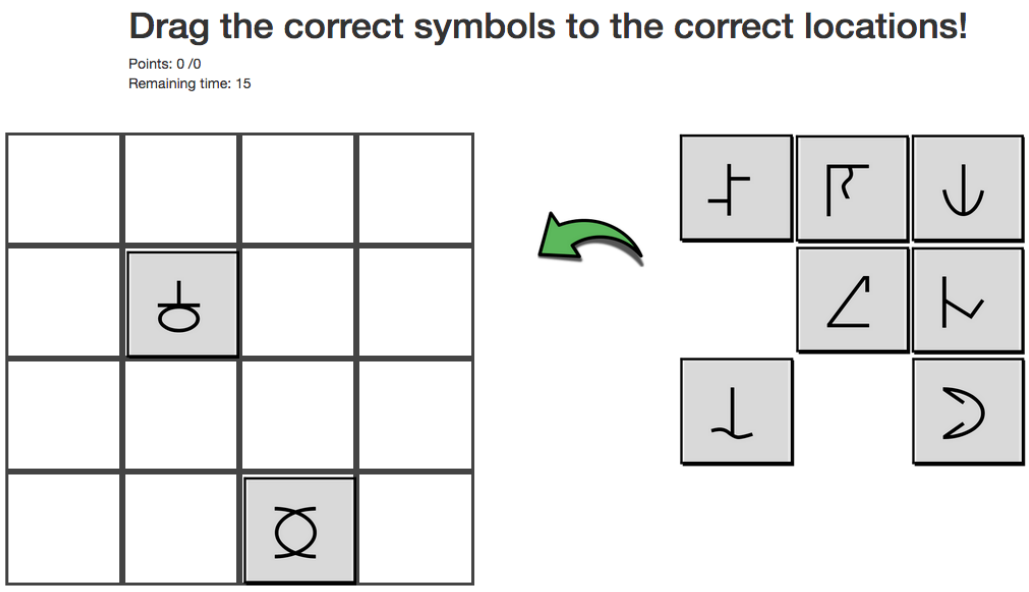


Figure 5.1. Screenshot of spatio-visual memory task based on Mulac et al. (1991). Participants had to recall symbols and their positions in a grid and move the relevant symbol to correct location.

Once this task had been completed, participants recorded their oral recollection of the creation story. They were given the opportunity to pause and continue recording, but were not allowed to return or re-record after advancing to the next task. This process, including the working memory distraction task, was then repeated for the second story and with the accent of opposite prestige. Story order and accent were both randomised for presentation in the experiment. Each participant heard 'Muki' in one accent condition and 'Taka and Toro' in the alternate accent condition.

After recording their recollections of both stories, participants listened to recordings of the *Comma Gets a Cure* passage read by the speakers providing the stories. To test that the accents were indexing prestige and these cues were differentiated across accents, participants rated the speakers using the items for the PRI scale of individual prestige (Berl et al., forthcoming; see Appendix B), as well as additional solidarity and dynamism domains (Fuertes et al., 2012). Finally, participants completed a demographic questionnaire including participants' residence history and self-reported accents of English. Data pertaining to gender and ethnicity were collected in line with local and ethical guidelines.

5.3.1.5 Data Coding and Transcription

We transcribed the audio files containing participants' story recordings, and coded each for the presence or absence of each proposition from the original texts (see Appendix E for coding protocols, and Appendix F for examples of transcripts and coded data). Because participants were instructed that they did not need to recall the stories verbatim, we counted the presence of a proposition when a participant used different word choices or constructions if the meaning remained constant, e.g. we accepted synonyms and we did not penalise the order of recall. If an error in the retellings was carried forward in the story, we only marked it absent in the first instance. We only counted biased propositions as present if the retelling retained the biased element (e.g. social interaction, counterintuitive properties).

To assess intercoder reliability, a second researcher re-coded a subset of 33 recordings (representing approximately 10% of the sample). We found substantial agreement between the coders (Cohen's $\kappa = 0.737$, $p < 0.01$), and coders discussed any disagreements until reaching consensus.

5.3.1.6 Data Analysis

We used a set of generalised linear mixed models (GLMMs) to model the presence or absence of a particular proposition. Here, we tested the effects of eight different transmission biases by fitting a set of 58 candidate models that account for the potential effects of these biases in isolation and in combination with one another (Appendix G). For these models, the fixed effects we examined can be broken down into three categories of: 1) *story-based effects* (story, presentation order, and line number[5] and quadratic line number (representing primacy or recency effects)); 2) *transmission biases* (prestige, social, survival, positive emotional, negative emotional, moral, rational, and counterintuitive domain); and 3) *demographic effects* (country, gender, ethnicity, accent matching low-prestige speaker, childhood town size, childhood town matching region of low-prestige speaker, education, occupation, income, and working memory score). We also included random effects

[5] Line number refers to position of the sentence in the narrative (i.e. the first sentence is the first line and the second sentence is the second line).

for participant and proposition number and included random intercepts, as our measurements varied on the individual level in all models, to capture the remaining variance from these sources. Figure 5.2 shows the factors that are likely to affect story recollection.

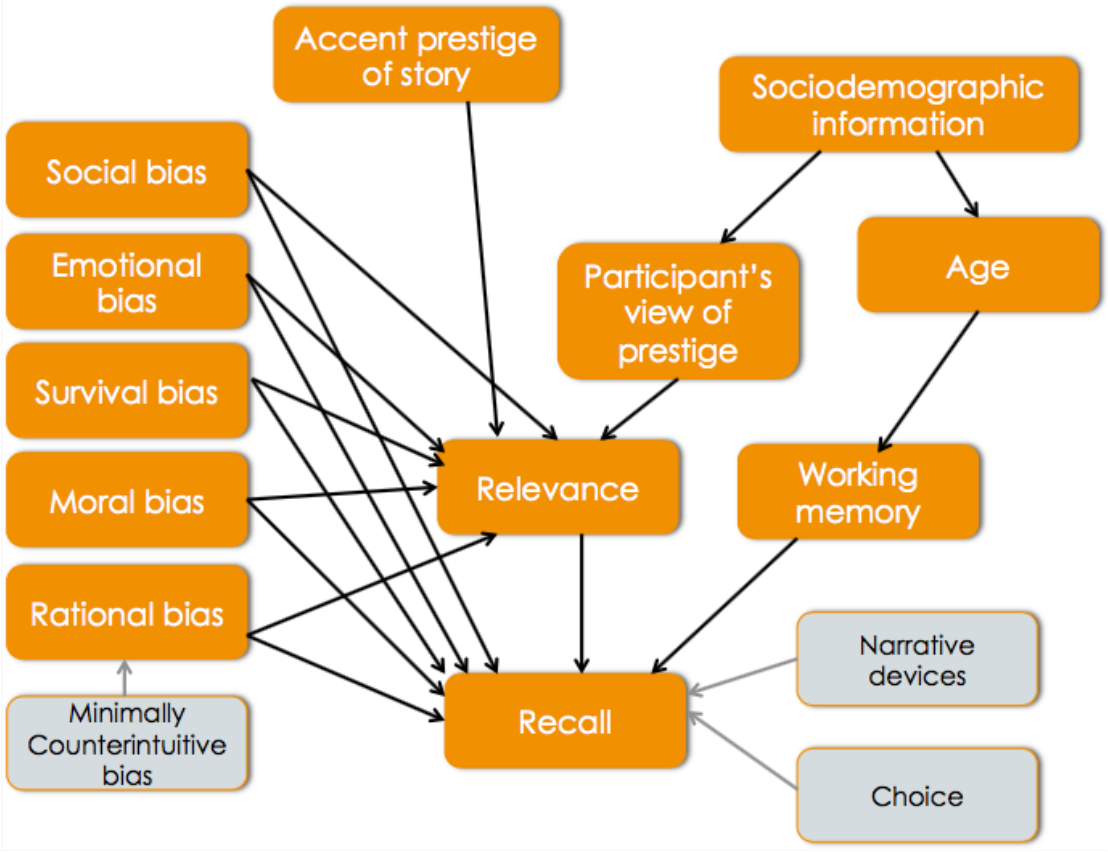


Figure 5.2. Causal diagram showing factors expected to influence story recall. Factors in orange are measured in this experimental design. Factors is grey may also influence recall but are not explicitly tested in this study.

After model fitting, model comparisons were made on the basis of each model's Akaike Information Criterion (AIC) score. Due to the lack of a single dominant model with a weight greater than 0.95, we averaged the parameters of all models according to their Akaike weights (Burnham and Anderson, 2002). As our main interest was in determining which factors had the strongest effects (Nakagawa and Freckleton, 2011), we determined full model-averaged parameter estimates using the 'zero method' (Burnham and Anderson, 2002; Grueber et al., 2011). This substitutes a value of zero for parameter estimates and errors in models where the parameter

does not appear and computes a weighted average for each parameter using the models' Akaike weights.

We re-fit the full set of models using a continuous measure of the participants' perceptions of the speaker's prestige (as factor scores from the PRI scale of individual prestige (Berl et al., forthcoming; see Appendix B)) rather than the binary high-low prestige variable, for the subset of participants that provided this information (roughly two thirds of the full data set). Results were qualitatively similar; however, direct comparisons cannot be made due to these analyses being performed on a non-random subset of the data.

We used the R statistical environment, version 3.5.1 (2018-07-02), for all analyses (R Core Team, 2018).

5.3.2 Results

5.3.2.1 Participants showed preferential recall of biased information

Of the final data set consisting of 87,420 narrative propositions presented to participants in total, 12,492 (6.998%) were recalled (Appendix H). Although the level of recall seems low, participants were not incentivised for accurate recall and the measurement only accounts for original propositions recalled rather than manipulated. The lengths of the stories used is much longer than previous research (Mesoudi, Whiten and Dunbar, 2006) and therefore poses a greater cognitive challenge. A significant difference was found between the proportions of content types presented and those recalled (z = -2.036, p = 0.042), showing that participants recalled some types of biased information more frequently than other types, including unbiased information (i.e. propositions that did not contain any of the examined content biases; Figure. 5.3).

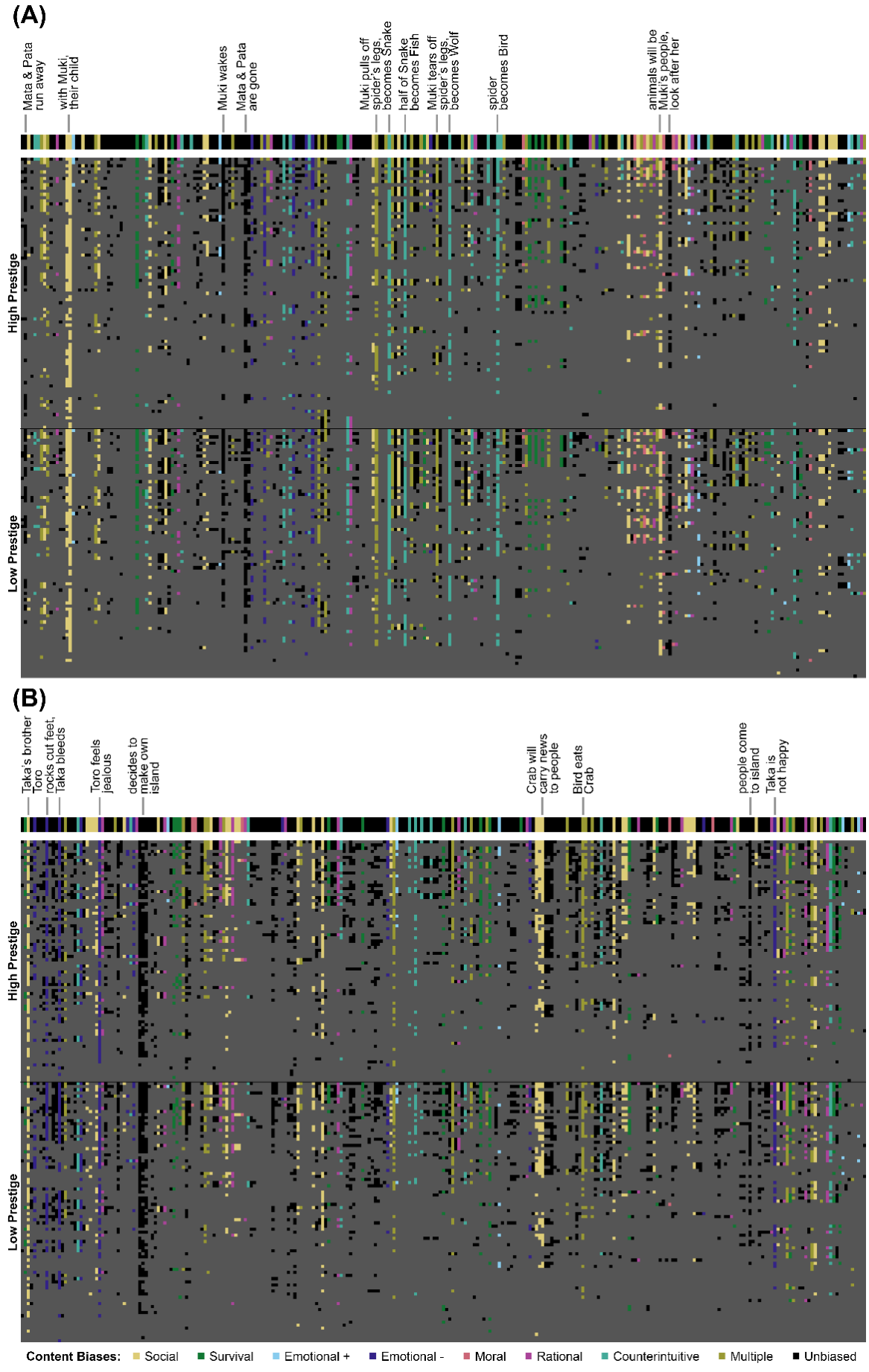

(A)
Mata & Pata run away
with Muki, their child
Muki wakes
Mata & Pata are gone
Muki pulls off spider's legs, becomes Snake
half of Snake becomes Fish
Muki tears off spider's legs, becomes Wolf
spider becomes Bird
animals will be Muki's people, look after her
High Prestige
Low Prestige
(B)
Taka's brother Toro rocks cut feet, Taka bleeds
Toro feels jealous
decides to make own island
Crab will carry news to people
Bird eats Crab
people come to island
Taka is not happy
High Prestige
Low Prestige
Content Biases: Social Survival Emotional + Emotional - Moral Rational Counterintuitive Multiple Unbiased

Figure 5.3. Colour matrices of the presence or absence of propositions in recalled stories. Each row represents one participant's recall (*n* = 165 per panel), sorted by hierarchical clustering for visibility. Each column is a proposition from the Muki (A) or Taka and Toro (B) artificial creation stories, from left to right in the order in which the propositions appeared in the stories. The thick line above each panel shows the full set of propositions contained in the story as originally told, with labels indicating propositions with exceptionally high recall (using Tukey's definition of outliers). Within each panel, rows in the upper portion were read by a high-prestige speaker, while rows in the lower portion were read by a low-prestige speaker. Dark grey propositions were not recalled (absent). Recalled propositions (present) are each represented by a colour that indicates the content biases they contained, as indicated at the bottom of the figure: *social* information is yellow, *survival* is green, *positive emotional* is light blue, *negative emotional* is dark purple, *moral* is pink, *rational* is magenta, *counterintuitive* is teal, and propositions containing more than one bias are gold. Unbiased propositions, those that did not contain any biased information, are shown as black.

Recall for each type of content bias ranged from a mean proportion of 0.066 of the propositions presented (moral) to 0.338 (biological counterintuitive). In general, small but non-significant differences were observed in the recall of content biases in high- versus low-prestige speaker conditions (Figure 5.4). Here, we split counterintuitive bias into the three measured domains as the counterintuitive information is skewed by one domain. We report the split bias results as there is no theoretical reason why a particular counterintuitive domain should be recalled above others and it is, therefore, a surprising finding to see such variation between counterintuitive domains. However, corrected pairwise comparisons of proportions showed that prestige had a significant impact on the recall of unbiased information ($p < 0.001$) and basic social information ($p = 0.001$). Additionally, unbiased information was recalled significantly less often than biased information under the same prestige condition, except for positive emotional, moral, rational, and physical and mental counterintuitive information. Of these, positive emotional, moral, and mental counterintuitive information were recalled significantly less frequently than unbiased information.

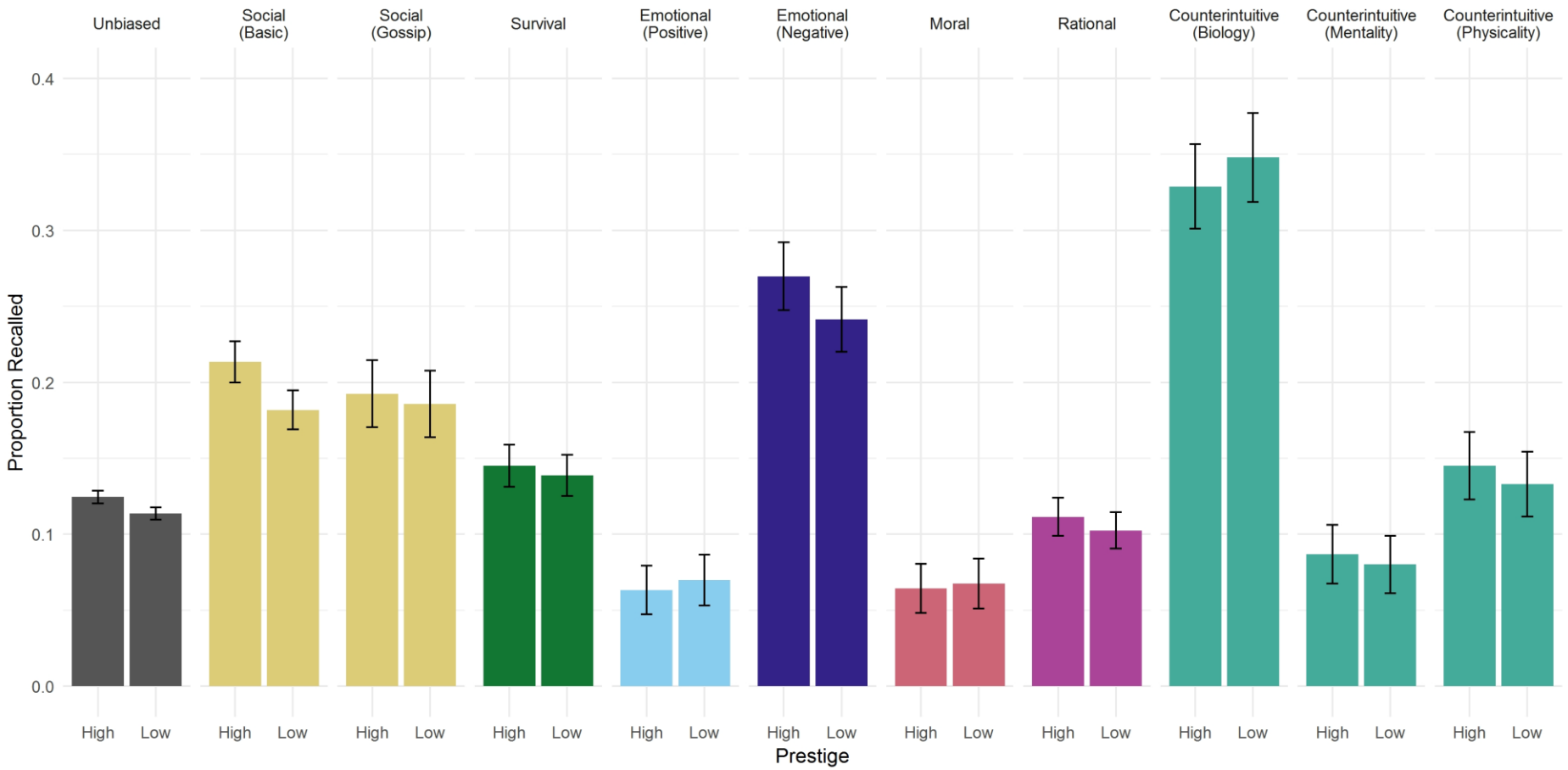


Figure 5.4. Mean proportion of propositions recalled from artificial creation stories by type of content bias and by speaker prestige. Error bars represent 95% confidence intervals. Propositions containing more than one type of content bias are excluded.

5.3.2.2. Content biases were more influential than prestige bias

To explain the variance in recall of specific propositions, we fit a total of 58 proposed models (see Appendix G) incorporating story-based, transmission bias, and demographic variables using maximum likelihood estimation. Eleven of the best-fitting models had a resulting ΔAIC score < 2, indicating no single 'best' model exists. The majority of the best-fitting models included variables for story presentation order, for prestige, social, survival, negative emotional, and counterintuitive biases, and for gender and working memory (Table 5.2).

Our results (Figure 5.5, Table 5.3) show that the transmission biases with the greatest effect on recall were, in descending order: counterintuitive (but only for biological violations), negative emotional, social, survival, and prestige. All other biases had negligible effects according to their model-averaged coefficients and confidence intervals and their relative variable importance values. Though we did find a significant effect for prestige, it was the weakest of the transmission biases, with an odds ratio of 1.163 (95% CI [1.118, 1.216]) compared to the next lowest, survival, with 1.855 (95% CI [1.214, 2.836]) and the strongest effect, biological counterintuitive, with 7.525 (95% CI [3.895, 14.537]). For story effects, participants had better recall for the second story they were presented, regardless of which story it was. The placement of propositions within the story had no effect on recall. For demographic variables, only working memory had a significant positive effect.

Table 5.2. Twenty best-supported models of proposition recall. Degrees of freedom (df) and log likelihood (logLik) and Akaike Information Criterion (AIC) values are provided for each model fit. ΔAIC is the change in AIC relative to the best-supported model. Akaike weights (w) were used in weighted model averaging and represent the relative likelihood of each model.

Name	Model	df	logLik	AIC	ΔAIC	w
Significant variables from full model without income ('A') with gender	present ~ firstStory + prestige + social + survival + emotionalNegative + counterintuitiveDomain + gender + memory	14	-26399.49	52826.97	0.00	0.114
A with gender and line number	present ~ firstStory + line + prestige + social + survival + emotionalNegative + counterintuitiveDomain + gender + memory	15	-26398.50	52827.00	0.02	0.113
A with gender and moral	present ~ firstStory + prestige + social + survival + emotionalNegative + moral + counterintuitiveDomain + gender + memory	15	-26398.64	52827.28	0.31	0.098
A with gender and positive emotional	present ~ firstStory + prestige + social + survival + emotionalPositive + emotionalNegative + counterintuitiveDomain + gender + memory	15	-26398.71	52827.43	0.45	0.091
A with gender and quadratic line number	present ~ firstStory + line + line^2 + prestige + social + survival + emotionalNegative + counterintuitiveDomain + gender + memory	16	-26398.11	52828.22	1.25	0.061
A with gender and town low prestige	present ~ firstStory + prestige + social + survival + emotionalNegative + counterintuitiveDomain + gender + townLowP + memory	15	-26399.13	52828.27	1.29	0.060
A with gender and country	present ~ firstStory + prestige + social + survival + emotionalNegative + counterintuitiveDomain + country + gender + memory	15	-26399.40	52828.81	1.84	0.046
Significant variables from full model without income ('A')	present ~ firstStory + prestige + social + survival + emotionalNegative + counterintuitiveDomain + memory	13	-26401.41	52828.83	1.85	0.045
A with line number	present ~ firstStory + line + prestige + social + survival + emotionalNegative + counterintuitiveDomain + memory	14	-26400.42	52828.85	1.87	0.045
A with gender and story	present ~ story + firstStory + prestige + social + survival + emotionalNegative + counterintuitiveDomain + gender + memory	15	-26399.48	52828.95	1.98	0.043

A with gender and rational	present ~ firstStory + prestige + social + survival + emotionalNegative + rational + counterintuitiveDomain + gender + memory	15	-26399.48	52828.97	1.99	0.042
A with moral	present ~ firstStory + prestige + social + survival + emotionalNegative + moral + counterintuitiveDomain + memory	14	-26400.57	52829.14	2.16	0.039
A with positive emotional	present ~ firstStory + prestige + social + survival + emotionalPositive + emotionalNegative + counterintuitiveDomain + memory	14	-26400.64	52829.28	2.30	0.036
A with town low prestige	present ~ firstStory + prestige + social + survival + emotionalNegative + counterintuitiveDomain + townLowP + memory	14	-26400.85	52829.69	2.72	0.029
A with gender and education	present ~ firstStory + prestige + social + survival + emotionalNegative + counterintuitiveDomain + gender + education + memory	17	-26398.02	52830.04	3.06	0.025
A with quadratic line number	present ~ firstStory + line + line^2 + prestige + social + survival + emotionalNegative + counterintuitiveDomain + memory	15	-26400.04	52830.07	3.10	0.024
A with gender and ethnicity	present ~ firstStory + prestige + social + survival + emotionalNegative + counterintuitiveDomain + gender + ethnicity + memory	16	-26399.24	52830.47	3.50	0.020
A with country	present ~ firstStory + prestige + social + survival + emotionalNegative + counterintuitiveDomain + country + memory	14	-26401.40	52830.79	3.82	0.017
A with story	present ~ story + firstStory + prestige + social + survival + emotionalNegative + counterintuitiveDomain + memory	14	-26401.40	52830.80	3.83	0.017
A with rational	present ~ firstStory + prestige + social + survival + emotionalNegative + rational + counterintuitiveDomain + memory	14	-26401.41	52830.82	3.85	0.017

Table 5.3. Full model-averaged coefficients for proposition recall. Relative variable importance ('RVI') is the sum of Akaike weights for all models that include that variable. Bolded *p*-values indicate statistically significant results at the 0.05 level.

Variable	Coefficient	SE	*p*-value	RVI
intercept	-2.876	0.149	**< 0.001**	
story	0.001	0.030	0.970	0.06
firstStory[6]	-0.706	0.045	**< 0.001**	1.00
line				
(linear)	-0.020	0.047	0.662	0.24
(quadratic)	0.005	0.027	0.844	0.09
prestige	0.151	0.023	**< 0.001**	1.00
social				1.00
(none-basic)	0.893	0.187	**< 0.001**	
(none-gossip)	0.841	0.305	**0.006**	
survival	0.618	0.216	**0.004**	1.00
emotionalPositive	-0.054	0.184	0.771	0.13
emotionalNegative	1.129	0.254	**< 0.001**	1.00
moral	-0.062	0.201	0.758	0.14
rational	-0.001	0.055	0.984	0.06
counterintuitiveDomain				1.00
(none-biology)	2.018	0.336	**< 0.001**	
(none-mentality)	-0.283	0.274	0.302	
(none-physicality)	0.599	0.357	0.094	
country (us-uk)	-0.004	0.045	0.935	0.06
gender (female-male)	-0.238	0.207	0.252	0.71
ethnicity				0.03
(white-poc)	-0.003	0.048	0.951	
(white-mixed)	0.006	0.072	0.929	
townChildhoodSize				< 0.01
(linear)	0.000	0.008	0.995	
(quadratic)	0.000	0.009	0.984	
(cubic)	0.000	0.008	0.999	
townChildhoodLowP (false-true)	0.020	0.097	0.837	0.09
education				0.03
(linear)	0.003	0.038	0.935	
(quadratic)	0.005	0.043	0.901	
(cubic)	-0.007	0.046	0.886	
occupation				< 0.01
(student-homemaker)	0.000	0.017	0.999	
(student-production)	0.000	0.019	0.997	
(student-trades)	-0.001	0.031	0.981	
(student-sales)	0.000	0.015	0.996	
(student-service)	0.000	0.015	0.991	
(student-professional)	0.000	0.014	0.998	
income				< 0.01
(linear)	0.001	0.028	0.985	
(quadratic)	0.003	0.073	0.970	
(cubic)	0.000	0.025	0.989	
memory	0.580	0.085	**< 0.001**	1.00

[6] The variable firstStory refers to whether this story was the first story presented to the participant.

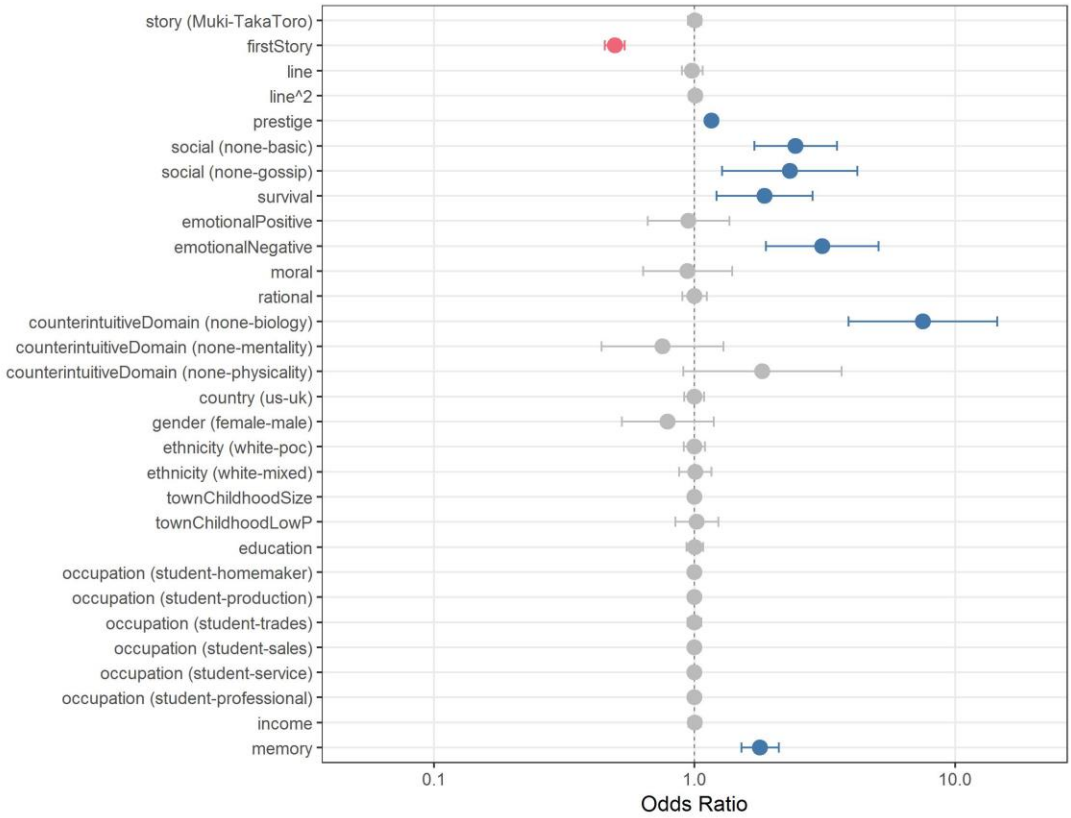


Figure 5.5. Forest plot of odds ratios from full model-averaged coefficients for fixed effects. Odds ratios and 95% confidence intervals are depicted such that variables for which confidence intervals do not overlap with 1 have a significant positive (above 1; blue) or negative (below 1; red) effect on proposition recall. Binary and categorical variables are represented relative to the reference level (false/not present unless specified otherwise). For ordinal variables (*townChildhoodSize*, *education*, and *income*), only linear contrasts are shown.

5.3.2.3 Transmission biases explain little variance in recall

The set of best-fitting models (ΔAIC < 2) had relatively high mean conditional R^2_{GLMM} values at 0.524 (SD < 0.001), but a lower marginal R^2_{GLMM} at 0.106 (SD = 0.002). The difference between the two values represents the proportion of the variance explained by the random effects of the model, which were the participant ID (i.e. individual differences) and proposition number. Comparisons of the lowest-AIC model with ones excluding either random effect were both significant (participantID X^2 [1] = 6516.1; proposition X^2 [1] = 9718.2; both p << 0.001), indicating that the individual participant and proposition effects were both influential. These results tell us that there is a great deal of variance in our responses that is not accounted for by the transmission biases and other fixed effects included in the models, and that this variance includes both individual variation and the stories themselves.

5.3.3 Discussion

5.3.3.1 Prestige bias has a small effect on transmission

We asked participants in two countries to orally recall stories told by speakers with accents of different status, and we found significant effects for prestige, social, survival, negative emotional, and biological counterintuitive biases (see Table 5.3, Figure 5.5). Prestige-biased transmission has been prominent in the cultural evolution literature (Boyd and Richerson, 1985; Jiménez and Mesoudi, 2019b; Atkisson, Mesoudi and O'Brien, 2012; Henrich and Gil-White, 2001; Henrich and McElreath, 2003; Richerson and Boyd, 2005; Chudek et al., 2012; Cheng et al., 2013). However, prestige bias, as proxied by accent, had the smallest effect on transmission, increasing the likelihood of a proposition's recall by only 15%. One possible explanation for the secondary importance of prestige concerns the nature of the narratives transmitted. Transmission biases can lead to the development of group markers and ingroup cooperation (McElreath, Boyd and Richerson, 2003; Boyd and Richerson, 2009; Boyd, Richerson and Henrich, 2011a), and creation stories themselves are representative of a shared group identity (Smith et al., 2017). If the audience does not perceive some cultural relationship between themselves and the storyteller or narrative, prestige may be a less pertinent cue for social learning. Indeed, prestige itself often exists as an ingroup hierarchy with less relevance to outgroup individuals (Henrich, Chudek and Boyd, 2015; Halevy et al., 2012).

Assuming that shared identity could be a factor mediating the efficacy of prestige bias—in effect, a similarity bias (McElreath, Boyd and Richerson, 2003)—we examined links between participant and storyteller demographics. We would predict from this argument that participants should better recall a narrative read by a speaker whose accent they could personally identify with. However, our results show no effect on recall from matching participants' childhood location with the region of the low-prestige speaker's accent (*townChildhoodLowP*; see Figure 5.5). Other potential effects of similarity bias were represented through standardisation of speaker demographics and inclusion of participants' demographics in the models;

however, no significant associations were found between participants' identities and those of the speakers.

5.3.3.2 Prestige bias is unconsciously employed as a secondary strategy

Another potential explanation for the low importance of prestige in determining recall is that participants may adjust their social learning strategies depending on which biases are present in different parts of the narrative (McElreath et al., 2008; Morgan et al., 2012; Rendell et al., 2011). We see clearly that when content biases were present participants largely ignored prestige cues, but tended to recall unbiased propositions more frequently when the narrative was told by a speaker with a high-prestige accent (Figure 5.4).

The finding that prestige takes a secondary role to content supports the conclusion of several models (Gong, Tamariz and Jäger, 2012; Tamariz, Gong and Jäger, 2011; Tamariz et al., 2014) and the only other study we know to have compared prestige and content experimentally (Acerbi and Tehrani, 2018). In this study, the authors found that the effects of prestige were minimal compared to content effects (in the form of 'inspiration' or general likability rather than specific biases) when attributing quotations to famous (i.e. prestigious) or unknown authors, but this may be because expertise was not relevant to the task. We suggest that, together, these empirical findings demonstrate the importance of content biases in directing cultural transmission. These content cues can be more nuanced than general context-based copying rules such as prestige, but our results show that content biases take a primary role over context. The next step is to understand how the relative importance of content versus context biases may vary across different sociocultural contexts, and the potential interactive effects between different forms of biases (for example, one character feeding another encoding both social and survival information).

5.3.3.3 Different content biases have distinct effects

As previously noted, we found that the effects of content types on information transmission varied widely (Figure 5.5). Although we might have expected a greater attention to 'gossip' over basic social interactions (Mesoudi, Whiten and Dunbar, 2006), the lack of a significant difference between the two in our results (Figure 5.4) could be due to variation in how gossip was defined. In this study, gossip was defined by the presence of third-parties in interactions and not by the 'intensity' of interaction as has been done previously (Mesoudi, Whiten and Dunbar, 2006). We chose to deviate from this model as intensity is subjectively defined and may have emotional confounds (e.g. surprise, disgust). The definition we provide based on third parties is objective and can be more easily applied in future studies. Furthermore, as entire narratives have previously been ascribed as gossip (Mesoudi, Whiten and Dunbar, 2006), any recall is attributed to this bias, whereas we coded each specific social interaction as basic or gossip. Here, the advantageous impact of social 'gossip' on transmission may also have been tempered by the cognitive load of processing multiple levels of theory of mind (Dunbar, 1998a, 2004). Humans struggle to cope beyond fifth-order intentionality (Kinderman, Dunbar and Bentall, 1998; Krems, Dunbar and Neuberg, 2016; Stiller and Dunbar, 2007), therefore the number of characters that participants have to hold perspectives for pushes these cognitive boundaries when combined with the experimental task set.

Our results also support multiple prior empirical studies that found strong positive effects on transmission for survival information (Stubbersfield, Tehrani and Flynn, 2015; Nairne, Thompson and Pandeirada, 2007; Otgaar and Smeets, 2010; Nairne and Pandeirada, 2010), and for negative emotional information but not positive emotional information (Bebbington et al., 2017; Heath, Bell and Sternberg, 2001; Kensinger and Corkin, 2003). Indeed, negative emotional information was found to be one of the most powerful biases in our stories (Figure 5.4). As negative information arouses strong emotional responses such as fear, disgust, and anger, it has been theorised that humans evolved broad cognitive domains receptive to negative information as a survival response to predators and toxic food sources (Al-Shawaf et al., 2016; Al-Shawaf and Lewis, 2017; Barrett, 2015; Boyer and Barrett,

2015; Tooby and Cosmides, 2008), which may explain why both survival and negative emotional information are particularly salient.

We did not find evidence to support a preference for moral, rational, or most counterintuitive information. Moral and mental counterintuitive information (as well as positive emotional, above) were actually recalled less often than unbiased information (Figure 5.4), though not enough to lead to negative odds ratios when other variables were accounted for (Figure 5.5). However, there has been very little prior work to test these biases in an experimental transmission paradigm. For instance, previous evidence of a bias for 'rational' or causal information has only been anecdotal (Bartlett, 1920). The transmission of rational information relies upon the retention of a predicate, therefore, rational bias may affect the recall of surrounding information but may not be reliably recorded. As we defined successful transmission of rational information as requiring the retention of the subordinating conjunction ('because', 'so that', 'when', etc.; the proposition coded as having rational content), this may explain why rational information is not recalled in our study. Hence, rational bias may have had a proximity effect on the recall of surrounding information, without being recalled itself, that was not detected by our analyses.

According to social norm theory, individuals should be expected to retain and transmit moral information depending, on, firstly, the strength of the social norm and, secondly, the extent to which they identify with the social group to which it applies (Cialdini and Trost, 1998; McDonald and Crandall, 2015). That participants did not recall moral information is less surprising if they recognised that the creation stories did not describe their own society's origins and/or rules of accepted behaviour.

5.3.3.4 Structural features of narratives may aid transmission beyond biased content.

To the best of our knowledge no existing theory addresses why particular counterintuitive domains should be recalled more frequently than others; however, our data demonstrates that biologically counterintuitive information was more likely to be transmitted. This is not necessarily due to biased content *per se*, but

rather could be a consequence of narrative construction. Many of the biological counterintuitive propositions in our stories were repetitive in structure (for example, in 'Muki', spiders were transformed into other animals four times in sequence) and recollection may be affected by what Jakobson (1960) called the 'poetic function of language' (Waugh, 1980). In our study design, we credit a causal role to linguistic factors in social learning through our use of accent-based prestige; narrative theory itself remains a rich and largely untapped resource in cultural evolutionary accounts of information transmission (Rivkin and Ryan, 2004).

For stories to be impactful, the content must engage the audience (Busselle and Bilandzic, 2009; Duranti, 1986; Graesser, Olde and Klettke, 2002) and compete for space in their working memory (Graesser, McNamara and Louwerse, 2003; Kormos and Trebits, 2011; Montgomery, Polunenko and Marinellie, 2009; Ward et al., 2016). To this end, stories (and their tellers) employ a suite of features to enhance their salience, including elements that evoke emotional arousal (Andringa, 1996; Hänninen, 2007; Komeda et al., 2009; Benelli et al., 2012) and the use of familiar narrative devices such as rich encoding and repetition (Genter, 1976; Thorndyke, 1977). As such, there are multiple factors influencing the success of story transmission and the data demonstrate that transmission biases alone do not capture this variation.

5.4 Study 2

5.4.1 Background

Study 1 exposed an interesting effect for emotional bias: whereas negatively-valenced information was more likely to be recalled, positively-valenced information was less likely to be recalled than even unbiased (or content free) information (see Figure 5.4). Beyond the content of the stories which explicitly evokes emotional bias, there is a body of research suggesting that we ascribe emotional value to words themselves (Adelman and Estes, 2013; Bestgen, 1994; Bradley and Lang, 1998; Kensinger and Corkin, 2003; Kensinger and Schacter, 2006; Kousta, Vinson and Vigliocco, 2009; Nielsen, 2011; Scott et al., 2018; Stevenson, Mikels and James, 2007; Warriner, Kuperman and Brysbaert, 2013). Emotional bias

may therefore also influence recall through the telling of the story, and we may scaffold emotional content through our word choice.

Here, we further investigate emotional bias by testing how emotional information is transformed through one generation of transmission. Using the Glasgow Norms word list (rating 5,553 words across nine scales) (Scott et al., 2018), we compare participants' recalled stories from Study 1 to the original stories along arousal and valence dimensions. We test across both dimensions as they together contribute to emotional processing (Bann and Bryson, 2013; Kensinger and Schacter, 2006; Kensinger, 2009; Kousta, Vinson and Vigliocco, 2009): valence defines whether the emotion is positive or negative; arousal determines the strength of the emotion (Adelman and Estes, 2013; Scott et al., 2018; Warriner, Kuperman and Brysbaert, 2013). Both arousal and valence dimensions used 9-point Likert scales to determine word scores.

We also test effects of accent-based prestige as accent has been previously shown to elicit different attitudinal perceptions. We have two expectations: 1) participants' stories should be more negative overall compared to the original stories based on the greater influence of negative emotional bias recognised in Study 1; and 2)recollections of stories that were originally told in prestigious accents would be more negatively-valenced than recalled stories that were originally heard in a low prestige condition, as lower prestige accents are often favourably considered along positive friendly dimensions (Coupland and Bishop, 2007; Kinzler and DeJesus, 2013; see Chapter 4.) As the original stories are the same for both high and low prestige speakers, we might expect cognitive dissonance (Festinger, 1962; van Veen et al., 2009) on the part of the participant in how they tell their retold stories to match what is expected from the original speakers.

5.4.2 Materials and Methods

5.4.2.1 Score Calculation

We calculated the arousal and valence scores separately for the original 'Muki' and 'Taka and Toro' stories, and for the stories as recalled by participants (n=153). We did this by attributing a value to each word that has been ranked in the Glasgow Norms list (Scott et al., 2018). Each word in the story is summed and averaged by

number of tokens scored. If a word is repeated in a story, each instance contributes to the weighting of the score (i.e. a story that uses the words 'cry' [AROU: 4.794; VAL: 2.735] multiple times and 'laugh' [AROU: 7.471; VAL: 8.412] once is more negative than a story that uses both 'cry' and 'laugh' once). Words present in the transcripts that are metacommentary by the researchers (e.g. 'child crying in background') were excluded from the analysis.

5.4.2.2 Data Analysis

Data were analysed in the R statistical environment using base packages. A Shapiro-Wilk's test suggests that assumptions of normality were not met for arousal and valence across all conditions of recalled stories, therefore, we ran a series of Wilcoxon's rank sum tests to compare means between original and recalled stories and prestige conditions.

5.4.3 Results

Table 5.4. Means and standard deviations for arousal and valence scores for participants' recalled stories.

Story	Prestige	Arousal		Valence	
		Mean	***SD***	***Mean***	***SD***
Muki	***Low***	4.821	0.164	5.670	0.364
	High	4.857	0.199	5.655	0.325
	Combined	4.839	0.183	5.663	0.345
Taka and Toro	***Low***	4.919	0.221	5.878	0.260
	High	4.886	0.159	5.863	0.188
	Combined	4.903	0.194	5.871	0.228

The original Muki and Taka and Toro stories have very similar scores for arousal [Muki: 4.884; Taka and Toro: 4.885] and valence dimensions [Muki: 5.738; Taka and Toro: 5.806]. Both original stories were relatively neutral for arousal and the words used in the stories are slightly positively valenced. Descriptive statistics for the four recalled story conditions can be found in table 5.4. As data for recalled Muki stories

were non-normal, we ran a series of Wilcoxon's rank sum tests to see whether arousal and valence scores differed between original and recalled narratives and between prestige conditions. All results were non-significant, suggesting that there is no difference between original and recalled stories for arousal and valence content. A summary of these results can be found in Table 5.5.

Table 5.5. Summary of Wilcoxon rank sum test results comparing original and recalled stories across arousal and valence dimensions.

Comparison	Muki				Taka and Toro			
	Arousal		Valence		Arousal		Valence	
	W	p	W	p	W	p	W	p
Original vs. recalled	96	0.6691	93	0.7189	77	0.9818	56	0.665
Original vs. high prestige	42	0.894	49	0.6569	38	0.9432	24	0.5852
Original vs. low prestige	22	0.4856	32	0.8046	40	1	47	0.7618
High vs. low prestige	2473	0.0987	3087	0.5581	3094	0.3526	2904	0.8246

5.4.4 Discussion

Here, we find no significant difference of emotion embedding in words in recalled stories or between prestige conditions. This is unexpected considering the wealth of literature suggesting that emotional content of words influence processing. However, this effect has been shown in studies of comprehension and holding attention (Benelli et al., 2012; Busselle and Bilandzic, 2008; Kensinger and Schacter, 2006; Komeda et al., 2009; Kousta, Vinson and Vigliocco, 2009) and we may not necessarily see this effect in the words used to transmit information.

There are also inconsistencies in direction of arousal and valence: recalled Muki stories are less arousing and more negative, while Taka and Toro stories use more arousing and positive language, whereas we would expect no difference between stories but between prestige condition. This suggests that language is an unreliable measure of emotional content for this context. Whereas many studies suggest that both arousal and valence affect emotional processing (Bann and Bryson, 2013; Kensinger and Schacter, 2006; Scott et al., 2018; Warriner, Kuperman

and Brysbaert, 2013), some research suggests that arousal is not necessary for us to recognise valence (Adelman and Estes, 2013). We did not ask participants to recall the stories verbatim and we see no effect of prestige condition. This implies that perceptions of the original speaker are not influencing the material transmitted or the language participants use in turn. As we expect some omission of original story events in the stories created by the participants, we would also expect negative information to be diluted in subsequent retellings. Whereas previous valence studies (Bebbington et al., 2017; Eriksson and Coultas, 2014; Heath, Bell and Sternberg, 2001; Stubbersfield, Tehrani and Flynn, 2017) have looked at recall and comprehension we find that subsequent retellings of Muki and Taka and Toro included the creation of new material, which has not been studied in this context. Although Study 1 shows that participants are likely to recall negative information, they are not creating negative stories. This suggests that recall may not be a sufficient measure of what is being transmitted, as any innovation is not captured. Considering the numerous biases influencing recall and transmission, participants may not be using latent emotional content in this case. Furthermore, participants were not told that the experimenter was their final audience and the experiment was set up as a recollection exercise. Participants may require an audience for these latent emotional biases to be expressed. Although we find no effect of emotional languages, this study demonstrates the utility of thinking about language as a mechanism of cultural evolution beyond propositional meaning.

5.5 General discussion: Implications for the understanding of transmission

In our main study, the overall fit of our transmission model is high (0.53), but fixed effects only explain a small portion of this (0.11). One possible explanation for this result is that some as-yet unidentified biases exist in the characteristics of the models or in the content of the stories, and this drives the variation in proposition transmission. However, our methodological approach included every type of content bias supported in the literature, and we could not test the remaining well-documented context biases, such as conformity bias (Efferson et al., 2008) and

success bias (Baldini, 2012), because they do not apply to the one-to-one transmission context of this experiment. In the future, if additional content biases are identified in the literature, it would be possible for researchers to re-code our data to test them.

Instead, the substantial explanatory power of the random effects in our models may represent the noise of individual variation. The trade-off for gaining real-world experimental validity is typically a greater amount of noise due to uncontrolled circumstances. Our methodological approach did not allow us to control the testing environments, including levels of distraction, participant's levels of attention, or participant's personal short and long-term histories. We attempted to maximise a realistic scenario with type of story, length and content controlled but in an ideal world, we would carry out a longitudinal study with multiple retellings of each story. As the stories were relatively long (5 minutes and 33 seconds) in experimental contexts, there were logistical reasons to presenting each story once such as the likely attention span of the participant and expected completion rates. Although a person is likely to hear a story (or variants of a story) multiple times over the course of their lifetime, they are unlikely to hear the same story repeated within a short amount of time. At a given point, we would expect a person to hear a story once, rather than multiple times in quick succession, therefore, it was more realistic to present the story once to the participant. In this way the experiment mimics real-world cultural transmission, which tends to be filled with random noise that can lead to low fidelity in one-off transmission events (Efferson et al., 2007; Strimling, Enquist and Eriksson, 2009). Much debate exists regarding the degree of transmission fidelity required for cumulative culture. Some argue that high-fidelity transmission is required (Tomasello, Kruger and Ratner, 1993; Tennie, Call and Tomasello, 2009; Lewis and Laland, 2012; Dean et al., 2014; Caldwell, Renner and Atkinson, 2018), while others counter that low-fidelity transmission is sufficient (Sperber, 1996; Sasaki and Biro, 2017; Zwirner and Thornton, 2015; McElreath et al., 2018; Miton and Charbonneau, 2018; Truskanov and Prat, 2018; Miu et al., 2018) and that weak biases can be amplified over repeated rounds of transmission to create strong universal patterns (Strimling, Enquist and Eriksson, 2009; Kirby, Dowman and Griffiths, 2007; Thompson, Kirby and Smith, 2016). We found that participants' responses to identical stimuli varied significantly and transmission

fidelity was often low. Participants knew they would need to retain and recite the information, but on average they recalled only 14% of the propositions presented (*SD* = 10%). In the context of a single-shot experimental transmission event, however, participants have no real incentive to retain information. Furthermore, there is evidence to suggest that repeated exposure to a story increases comprehension (Dennis and Walter, 1995), and narratives that particularly define a group, such as creation stories, are often told multiple times (Norrick, 2007) or are collaborative, with opportunities for audience engagement, allowing audience members to transform and take ownership of a narrative (Lawrence and Thomas, 1999; Norrick, 1997). Future work, both theoretical and empirical, should consider how models of transmission processes can accurately incorporate individual variation in cultural transmission and responses to content.

Our novel methodological and analytical framework provides a template for future tests of the simultaneous effects of context and content biases. We have performed the first experimental study that tests the relative effects of multiple types of cultural transmission biases presented within a realistic package of narrative information, while also incorporating linguistic factors that have, until now, gone unexplored in the cultural evolution literature. Although we found that prestige was the least important transmission bias, it was still a significant factor in participants' choices of what information to retain and recall, especially for information lacking any internal biases. Our results suggest that the prominent role of prestige-biased transmission models in cultural evolution studies should be scrutinised more heavily and qualified by the presence or absence of other biases, which may have stronger effects under certain conditions. The experimental framework presented here sets the stage for future research to test longstanding questions in cultural evolution, such as: which biases are necessary or sufficient for the development of cumulative culture (Tomasello, Kruger and Ratner, 1993), which conditions cause learners to favour one type of bias over another (Rendell et al., 2011), whether and how the effects of different biases differ cross-culturally (Efferson et al., 2007; Mesoudi et al., 2014; Eriksson, Coultas and Barra, 2016; Leeuwen et al., 2018), how micro-level transmission processes lead to macro-level cultural change (Mesoudi, Whiten and Dunbar, 2006; Schwartz and Mead, 1961), and how we can identify the bias or biases responsible for a *post hoc* distribution of

traits (Kandler and Powell, 2015). The results of this study go beyond academic discourse in cultural evolution to impact other disciplines that rely on the theory and application of communication as a means of disseminating information and motivating behavioural change, including education, marketing, conservation, public health, and political science. Storytelling persists as a powerful and enduring tool, dense in cultural information, and utilised across the world to share knowledge and shape the diversity of human culture.

Chapter 6: Narratives as a Tool for Capturing (Cultural) Diversity: A Novel Application of the *Family Problems Picture Task*

6.1 Abstract

Storytelling is universal. However, how we employ stories vary from culture to culture. I seek to understand the longstanding tradition of storytelling and why it is so widely used to preserve and transmit information and argue that it is the flexibility of storytelling that determines the utility of narratives. I have adapted the *Family Problems Picture Task*, an image-based storytelling task, to contribute to different fields of enquiry within cultural evolution. I investigate how stories are created and co-created, and how prior exposure to information affects variation. Here, I present results from a study with English speakers (n=32) exploring how we construct narratives both individually and cooperatively. I discuss the impact of narrative structure and performance in the embedding of context-based information that can scaffold social learning. Participants consistently flagged issues pertaining to social norms as highly important across all stories created, suggesting that despite variation across multiple areas of storytelling, this information is retained over successive iterations of story creation.

6.2 Introduction

Narratives have been used in many studies as a tool for determining the likelihood of information being transmitted across multiple biased domains (Barrett and Nyhof, 2001; Bebbington et al., 2017; Heath, Bell and Sternberg, 2001; Kroneisen and Erdfelder, 2011; Mesoudi, Whiten and Dunbar, 2006; Stubbersfield, Tehrani and Flynn, 2015). However, storytelling is rich in other contextual information that can influence our decisions about how and what to transmit. The previous chapter investigated the effect of both bias and linguistic factors on the recollection of

narratives. However, we found that these factors only explained a relatively small proportion of variance. There are many other factors that contribute to why certain stories are successful; this chapter focuses on how we compose narratives and how this constrains and transforms the different types of information included. Here, I use 'narrative' and 'story' interchangeably. In this chapter, I present an adaptation of the *Family Problems Picture Task* and demonstrate novel applications of this elicitation task that may highlight other factors that contribute to the success of a story. Here, I explain how this elicitation task developed by linguists can be adapted to study different aspects of cultural evolution and can be used cross-culturally. The aims of this chapter are twofold: 1) to investigate early cultural evolution of narratives as they are created and co-created; and 2) to explore the diversity of narratives as they are culturally constrained.

6.2.1 Narratives as a tool for capturing diversity

Storytelling is found across cultures and across a broad range of contexts and purposes. Storytellers themselves have been found to be preferred co-residents (Smith et al., 2017) and storytelling has been shown to increase a storyteller's reproductive fitness in certain contexts (Scalise Sugiyama, 1996). Narratives have been used as a way to document information such as histories or migration routes (Brockmeier, 2002; Rowe, Wertsch and Kosyaeva, 2002; Vansina, 1985). They have also been used to educate (de Young and Monroe, 1996; Piquemal, 2003; Yeoman, 1999), to advertise (Chang, 2009; Delgadillo and Escalas, 2004) and for entertainment purposes. Stories have also been used as a way to promote and reinforce social norms (Moran et al., 2013; Smith et al., 2017). Whereas there is certainly great utility in storytelling, these tasks can be achieved through other means such as direct orders. Why therefore are stories so frequently used as a way to transmit information?

I argue that storytelling is a popular strategy because of its versatility. Storytelling permits variation in both content and presentation, which allows for narratives to be tailored to the needs of both storyteller and audience. There are also different methods of storytelling: stories can be told through different media such as writing, orality, and even dance. Through different forms of narrative we can

establish vectors for information transfer at different scales. For example, an anecdote may suffice for small group transfer of simple information, yet we may require a written account that can be reviewed more than once for more complex information and to reach wider audiences. As the audience and complexity of the information varies, we can use more suitable narrative styles. Not only can narratives be used to transmit different content, the way in which we tell stories can be used to engage audiences in different ways.

6.2.1.1 Narratives as a tool for reaching broad audiences

Literacy is a relatively new phenomenon in our human past, therefore, information is likely to have been passed down through oral traditions for much of human history (Scalise Sugiyama, 2011), suggesting that oral storytelling is an important domain of study for cultural evolution. Stories can employ many features to aid recall including emotional arousal (Andringa, 1996; Benelli et al., 2012; Hänninen, 2007; Komeda et al., 2009) and narrative devices from large scale hierarchical organisational structures (or schemas) and to low-level repetition (Genter, 1976; Thorndyke, 1977). Whilst narrative structure (see section 6.2.1.2) has been shown to enhance recall by priming audience for content, content biases have also been shown to have an effect on the transmission of stories (Mesoudi, Whiten and Dunbar, 2006; Heath, Bell and Sternberg, 2001; Norenzayan et al., 2006) (see Chapters 2 and 5). This makes storytelling a particularly useful tool for transmitting different types of information, but what makes narratives so engaging over other methods of communication?

Storytelling is only useful if there is an audience. Stories are shaped based on the needs and interpretations of the audience (Duranti, 1986). Storytelling provides a structure in which to embed and signal important information and this structure can be adapted to suit a broad audience. Stories can appeal to emotional relevance (Velleman, 2003) and they appear to do this by illustrating a scenario in which the audience can empathise with characters or insert themselves into the narrative (Busselle and Bilandzic, 2009; Cohen, 2001). We can indicate important information through devices such as repetition and overt signalling in performance (e.g. the

titling of a written story or through encouraging audience participation in pantomime).

Through storytelling, we can take complex information and embed it in a form of entertainment designed to capture audience attention (Dudukovic, Marsh and Tversky, 2004; Senzaki, Masuda and Ishii, 2014; Slater and Rouner, 2002). Storytelling has already been applied to many areas of science communication because it is a familiar format that builds trust and indexes experiential learning (Dahlstrom, 2014; Fanini and Fahd, 2009; Green, Grorud-Colvert and Mannix, 2018; Haigh and Hardy, 2011; Jacobson, McDuff and Monroe, 2015). For example, Somali and Latino people with type II diabetes have created digital stories based on their own experiences with the illness as an intervention to promote and reinforce healthy behaviours for migrant and refugee communities in Minnesota, US (Njeru et al., 2015).

6.2.1.2 Constructing stories

Storytelling is a collaborative process. Even with a single storyteller, an audience must be engaged for a story to be successful. Storytelling can be a performance, but often storytelling is a conversation with interjections throughout which shape the narrative (Lawrence and Thomas, 1999; Norrick, 1997, 2007). When a story is told it is not directly transmitted; it must be comprehended (as a mental representation) and then is often transformed in the process of transmission again. As such there are many factors that affect how we build stories, capture attention and transmit information.

Lwin's (2017) study of storyteller performance using the audience as a co-collaborator demonstrates how storytelling utilises multiple devices to engage with the audience, for example, gesture and scaffolding retention by using memory aids such as writing on a white board. In this instance, a storyteller performs a story about a king challenging people to bring him a new tasty food and requests that the audience contributes to the creation of the narrative by supplying additional information. Questions are posed such as: 'or what kind of shoes?' and the descriptive elements the audience creates are weaved into the narrative. The

storyteller maintains control of the characters and the event arc – the questions are formed to make it is impossible for the audience to deviate from the proposed storyline – however, this type of collaboration is dependent on the participating audience sharing the same logical reasoning for events to take place.

Schemas or grammars were particularly popular in the 1970s and 1980s to understand how stories are structured (Beaugrande, 1982; Brewer, 1982, 1984; Genter, 1976; Johnson and Mandler, 1980; Mandler, 2014; McVee, Dunsmore and Gavelek, 2005; Pratt et al., 1982; Prince, 2012; Thorndyke, 1977; van den Broek, Lorch and Thurlow, 1996). For example, Thorndyke (1977) organises narrative based on high-level themes and plot devices and low-level characters and states; but Genter (1976) suggests that structure is based on the causal 'initiate', 'motivate' and 'allow' relationships between these events.

Graesser et al. (2002) propose a constructionist theory whereby storytellers create their stories based on assumptions of audience knowledge. The authors suggest six levels that are used in the construction of stories and for which mental representations are created in the minds of the audience: 1) the *surface code,* which dictates how the story is told exactly; 2) the *textbase*, by which meaning is represented through propositions; 3) the *situational model*, which contains the setting and context of the story; 4) the *thematic plot*, which established the take home message or point of the story; 5) the *agent perspective*, which acts as a referential point to ground the audience; and finally 6) the *genre*, or category of narrative which often has a typical structure which can signpost the audience of what to expect (Graesser, Olde and Klettke, 2002). I used this theoretical framework to determine which aspects of storytelling may show variance in tools that can be used to scaffold retention of information in an audience. Although I am not explicitly interested in comprehension in this study, the value of comprehension is under-represented in social learning studies. Whereas most transmission studies of narrative focus on retention of information on the part of the person told a story (Bartlett, 1920; Eriksson and Coultas, 2012; Lyons and Kashima, 2006; Stubbersfield, Tehrani and Flynn, 2017), the popularity of a narrative version (Norenzayan et al., 2006) or both (Stubbersfield, Tehrani and Flynn, 2015), there is little research on the active strategies a storyteller may use to enhance

comprehension and retention of the information they pass on. I emphasise this audience comprehension-based narrative theory as rich for testing empirically.

In this chapter, I will focus on levels 3-5 of this constructionist theory to investigate how stories are culturally constrained (level 3), whether important information is retained (level 4), and different ways in which this information is signalled (level 5). To do this, I carried out a study exploring the utility of a picture-based narrative task for understanding storytelling in a cultural evolution context.

6.2.2 The Family Problem Picture Task (FPPT)

The FPPT (San Roque et al., 2012) is a collaborative storytelling task that was designed for field- and sociolinguists to elicit various types of descriptive, reported, conversational and narrative speech to do with social relationships. Like other tasks designed for cross-linguistic comparison (Berman et al., 1994), it uses pictorial stimuli to elicit conversational speech. The set of 16 images were designed to stimulate discussion regarding the depicted events and their potential order (see Table 6.1). The standard protocol for the task is comprised of three parts: 1) participants, in pairs or small groups, describe what is happening in individual pictures; 2) they put the images in a sequential order; and 3) participants construct and present a coherent narrative relating the images together to an audience who has not observed the first two parts of the task. This task is video recorded.

6.2.2.1 Cross-cultural comparisons

The task has previously been carried out with small groups of speakers in over twenty languages including Awiakay (Papua New Guinea), Duna (Papua New Guinea), Iwaidja (Australia), Japanese (Japan), Ku Waru (Papua New Guinea), Lamjung Yolmo (Nepal) and Ngarinyin (Australia). San Roque et al. (2012) reported their findings and made cross-cultural comparisons amongst those languages; this study will be the first study to carry out this task with British English speakers. Previous investigations have demonstrated that participants view the task through their own culturally appropriate lens and thus what we find should be

specific to the population studied. In this section I will explore some of the findings San Roque et al. have found in their applications of the FPPT across different groups.

Previous studies have shown that stories culturally vary in: 1) perspective taking; 2) identification of people (particularly in respect to kinship); 3) identification and importance of inanimate objects; 4) interpretations of graphical conventions (e.g. the use of thought and speech bubbles, and shading); 5) how images are presented (e.g. in a grid or linear format); 6) storytelling performance; and 7) elicited linguistic features (e.g. epistemic markers and quoted utterances), which is not discussed in this chapter (San Roque et al., 2012).

Variance in taking different points-of-view and performing these roles has already been established (San Roque et al., 2012). One expectation is that participants would tell the story from the role of a third-party narrator, however, San Roque et al. found that an Iwaidja participant innovated the use of first-person perspectives in retelling stories. Ku Waru speakers asserted that stories should not be told but performed and so took on the role of the characters in the story (San Roque et al., 2012). This initial variation opens up more avenues for the creation of different stories: with multiple participants more roles can be portrayed, and participants must decide who the primary characters are.

San Roque and colleagues also found that interpretations of scenes are entrenched in the particularities of local cultural norms. For example, the 'homecoming' scene (see picture 1, Table 6.1) was interpreted as a negotiation of bride-price by Ku Waru speakers. Here, we see norms indexed about how different kin relationships are interpreted. For example, Duna participants referred to the man portrayed in the 'drunk gossip' scene speech bubble (see picture 4, Table 6.1) as a classificatory father to reflect norms surrounding affinal relationships (San Roque et al., 2012). As such we would expect characters' relationships to be defined within the bounds of kinship systems and social norms applicable to UK-based English speakers.

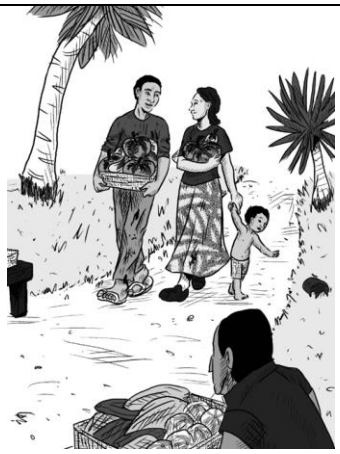
The value speakers ascribed to different objects and aspects of the images also shaped the stories that were created. For example, the bottles present in the drinking scene (see picture 7, Table 6.1) are unlabelled and, therefore, open to interpretation. Lamjung Yolmo speakers interpreted the contents as medicine because alcohol is unfamiliar in their community, which has a profound impact on

the stories that may be shaped. For participants unfamiliar with certain graphical conventions, this task contains some novelties. For example, perspective-drawing technique may confound the perception of relative size. A Duna speaker interpreted an old man who is often seen in the background as a child, because his relative size is small if assuming a flat aspect image (San Roque et al., 2012).

As English speakers created the images, we do not expect to find significant variation based on graphical conventions in our results. The cross-cultural variation displayed suggests that results from any one population cannot be broadly generalised but can be compared to investigate culturally influenced similarities and differences. As the task was created in a Westernised, educated, industrialised, rich and democratic (WEIRD) context, and our study will be carried out with WEIRD participants, we expect participants to stick to the canonical order established by San Roque et al. (2012). In its simplest form, the typical Western story is when "one thing happens in consequence of another" (Frank, 2010, p.25). Therefore, we might expect our participants to focus on logical sequential events rather than other aspects of storytelling such as performance. Storytelling is present in everyday conversation (Norrick, 2000), and there have been many studies with WEIRD children suggesting that children engage in storytelling through play as a way of allowing them to better understand their world and to work collaboratively (Benson, 1993; Cassell and Ryokai, 2001; Hoffmann and Russ, 2012; Kim, 1996; Malian, 1996; McGrath Speaker, Taylor and Kamen, 2004; Nicolopoulou, McDowell and Brockmeyer, 2006; Pellegrini, Dupuis and Smith, 2007; Ryokai and Cassell, 1999). Here, we provide an opportunity for adults to engage in collaborative storytelling in the same way and investigate whether the stories created are culturally constrained by norms and format.

Table 6.1. Images in order of presentation to participants for the FPPT as given in the original comparative work. Canonical order refers to the sequence in which the story was originally designed. Descriptions are edited from San Roque et al. (2012).

Presentation Order	Description	Image	Canonical Order
1	Homecoming: A man approaches a house where a woman, child and older man are. They watch the man with wariness.		**N**
2	Receiving clothes: A uniformed man hands the man a folded pile of clothes. There are bars on the doors.		**L**
3	In jail: The man sits in the corner of a dark room with barred windows. There is a plate of food on the floor next to him.		**J**
4	Drunk gossip: A group of men are holding bottles and talking. There is a speech bubble with an image of the woman talking to another man.		**D**

Presentation Order	Description	Image	Canonical Order
5	Courtroom: The women is seen bandaged with a speech bubble showing her being struck by the man. The man is sitting with his face in his hands.		**H**
6	Walking together: The man, woman and child walk together carrying baskets of produce.		**B**
7	Drinking: The man is sitting drinking with a group of men. There are unlabelled bottles surrounding them.		**C**
8	Gardening: The man and woman are picking pumpkins together in a garden.		**A**

Presentation Order	Description	Image	Canonical Order
9	Arrest: The man is dragged away by two men in uniform. The woman and child are huddled, injured. There is a smashed bottle near her.		**G**
10	Thinking about jail: The man has two thought bubbles depicting him being beaten by police and him looking through bars. He is wearing handcuffs.		**I**
11	Refusing to drink: The man and child walk past men offering bottles. The man walks past holding his hands up.		**P**
12	Punching: The man is punching the woman who a holding the child. He has a bottle in his hand. An older man witnesses this in the background.		**F**

Presentation Order	Description	Image	Canonical Order
13	Talking with family: The man sits with the woman and child. There are speech bubbles showing him sitting in a dark room and by a window.		**O**
14	Standing happy: The man stands outside a building looking towards the sky.		**M**
15	About to hit: The man has his fist raised to the woman. His speech bubble shows the woman touching another man. Her speech bubble shows her conducting a transaction.		**E**
16	Thinking of home: A man sits in a dark room with bars on the window. There is a thought bubble showing the man approaching a house. The child runs toward him.		**K**

6.2.2.2 Social learning and the FPPT

Although the FPPT was devised to elicit speech for linguistic analysis, we can adapt the task to investigate questions in cultural evolution. As evidenced in Chapter 3, socially-focussed studies of language have many aims and topics in common with cultural evolutionary anthropology, and the task itself bears relation to the general framework of transmission-based experiments. Stories require an audience, whether present or not, and so by asking participants to construct narratives we can determine the types of information that are likely to be passed on, allowing us to investigate the effects of different transmission biases in a realistic way. Here, we are not requiring individuals to recall information but rather actively establish what stories they wish to create.

The FPPT is usually carried out in pairs or small groups of individuals who know each other well (San Roque et al., 2012). The task involves three stages. Firstly, two participants are presented with each image on its own and asked to describe what is happening in each. Then, participants are asked to order the images together to create a narrative. Finally, participants are asked to tell the story twice from both first- and third-person perspectives. These stories are preferably told to an audience that had not heard the story before or are familiar with the images.

This task employs line drawings as stimulus material. By using pictorial stimuli, we can understand what information to which people are initially attuned. I specifically looked at information that corresponded to content biases (see Chapter 2 and Appendix C). The images are designed to elicit different types of information, depicting *social* interactions between multiple individuals. Although the features of the characters are ethnically ambiguous (San Roque et al., 2012), the events should elicit *emotional* responses from participants completing the task and the images show characters displaying emotion themselves. There is environmental information present which can be used to exploit *survival* bias; punishment establishes potential *moral* information as well, allowing us to test the presence and transformation of established biased content (Croson and Konow, 2009; Heath, Bell and Sternberg, 2001; Mesoudi, Whiten and Dunbar, 2006; Stubbersfield, Tehrani

and Flynn, 2015). As such, this task can explore the different constraints on narratives that can make it a useful framework for transmitting information.

This task also allows us to investigate participants' conscious decision-making strategies by asking them to verbalise these decisions in dyads. We can see how pairs negotiate what information should be included; determine their attachment to stories they have previously created; and, by asking participants to create multiple stories, their reliance on asocial and social learning. Furthermore, as participants hold multiple variants of the story through their individually created stories, their collaborator's individual story, and their co-created stories, we can use these narratives as outputs from multiple cultural parents and begin to test this effect. We might expect that information that is shared in both individual stories is more likely to be included in co-created narratives and stories they may later create. Participants have the opportunity to create stories based on their previous experience with the material, with stories they have learnt from others, or can innovate anew, demonstrating the stability and evolution of variants.

The FPPT is ideally suited to studying cultural evolution: it provides a structure whereby there is potential to investigate written and oral transmission of information and how this varies without over-determining the original information. Although the images and mode of transmission provide some structure, this task is open-ended enough to enable storytellers to create narratives that *they* are likely to transmit. However, here I focus on how the method can be adapted, rather than the transmission of information, and evaluate whether the data elicited provide the opportunity to study transmission in more controlled conditions. I specifically consider whether the FPPT can be used to study:

(a) whether participants sequence the events differently when working in pairs, allowing us to understand group dynamics better and to infer some of processes taking place when participants are presented with multiple story variants;

(b) the types of biased content information that participants include in their stories, and how this changes with greater familiarity with the material and exposure to potential variants of the story; and

(c) whether information that participants deem to be important is preserved over successive iterations of story creation.

In this study, participants created up to three versions of the same story: first individually; then as part of a pair; and, finally, individually again. I measured the quantity of biased information contained in each story and tracked how participants order the images and what individuals self-declared as the most important scene in each iteration of their story creation.

6.3 Methods and Materials

6.3.1 Participants

I recruited 14 women and 18 men (mean age = 27.8 years, SD = 8.22) by email and announcements via University of Bristol mailing lists, and by word of mouth. Participants were not limited to students, but all were associated with the University of Bristol. Where possible, individuals were paired up from different departments of the university to minimise the possibility of participants knowing each other. I used same sex dyads in this study to minimise gender effects (Maccoby, 2002; Ridgeway and Smith-Lovin, 2006). Participants took part in this study voluntarily and received no compensation. As all participants were recruited through the university, I assumed that they had a suitable level of English to take part in this elicitation task. I collected data on age, gender and whether participants considered themselves to be 'native-level' speakers of English; however, it was not deemed to be a requirement because English is widely spoken as a contact language and is not ethnically-specific (Jenkins, 2006; Seidlhofer, 2005).

6.3.2 Images

I presented the sixteen black and white line drawings created for the FPPT, which show multiple individuals interacting in various social situations (see Table 6.1). A core set of characters (a man, woman and child) appear frequently throughout the images and can be likened to a family group; however, stories are not required to include explicit kinship ties. I presented the task as the 'Social Issues Picture Task' and no reference was made to family relationships. The images also depict multiple activities (including conflict), which can be put in any order to create a story. These

characters were designed to be ethnically neutral, whereby the characters should not have any features that are ethnically distinguishing. For this study the whole set of sixteen images was used (see Table 6.1).

6.3.3 Protocol

This study took place in three phases. Two were carried out in a laboratory setting and the third was completed one week later at home. I explained to participants that the third part of the study was optional. Ethical approval was gained from the University of Bristol Faculty of Arts Research Ethics Committee and all participants were presented with a Participant Information Sheet (see Appendix I). Consent was obtained using an online web platform and a copy of the consent form can be found in Appendix J.

The first phase on the study was completed individually in the laboratory (see Figure 6.1) and delivered onscreen via a custom web application (https://transmission.excd.org/html/storyOrder.html?storyOrder=true). The application was written using the SurveyJS library (source code is available at: https://github.com/seannyD/StoryTransmission)[7]. A 15-minute timer was present on screen and participants were warned beforehand about the time limit for this phase. After giving their consent, the timer began and participants viewed the 16 monochrome line drawings in a randomly presented order. They were asked to sort (via clicking and dragging) the pictures into whatever order they wanted to create a story. After clicking through to the next page, participants were asked to write a story based on the images. They were instructed to 'write first what they thought was most important'. Participants were unable to change the order of the pictures at this point and therefore had to write their story in boxes referring to each scene. When the 15 minutes was over, the application moved on, regardless of whether participants had finished completing their story. There was a time limit to simulate real communication constraints and to encourage participants to prioritise important information. Examples of the stories written in the first phase can be seen in Appendix K. After completion of this task, participants were asked to choose

[7] Sean Roberts designed and implemented the web application, and created Figures 6.2-4 and 6.8.

onscreen which scene they thought was the most important and to write their reasoning.

The second phase of the study followed immediately after the first and was carried out in same-sex dyads to control for gender effects. Participants sat together at a large table and were given 220mm by 201mm laminated copies of the same 16 images they had seen in the first phase of the study. For all dyads, these images were presented in the presentation order (see Table 6.1) used by San Roque et al. (2012). They were instructed to order these images and to create a story, which was to be told orally. The researcher left the room whilst the pairs created this story so as not to influence their decision-making. The process was audio- and video-recorded using two video cameras (Zoom Q8; Sony Action Camera) and a dictaphone. Figure 6.1 shows the physical set up of the task in the laboratory.

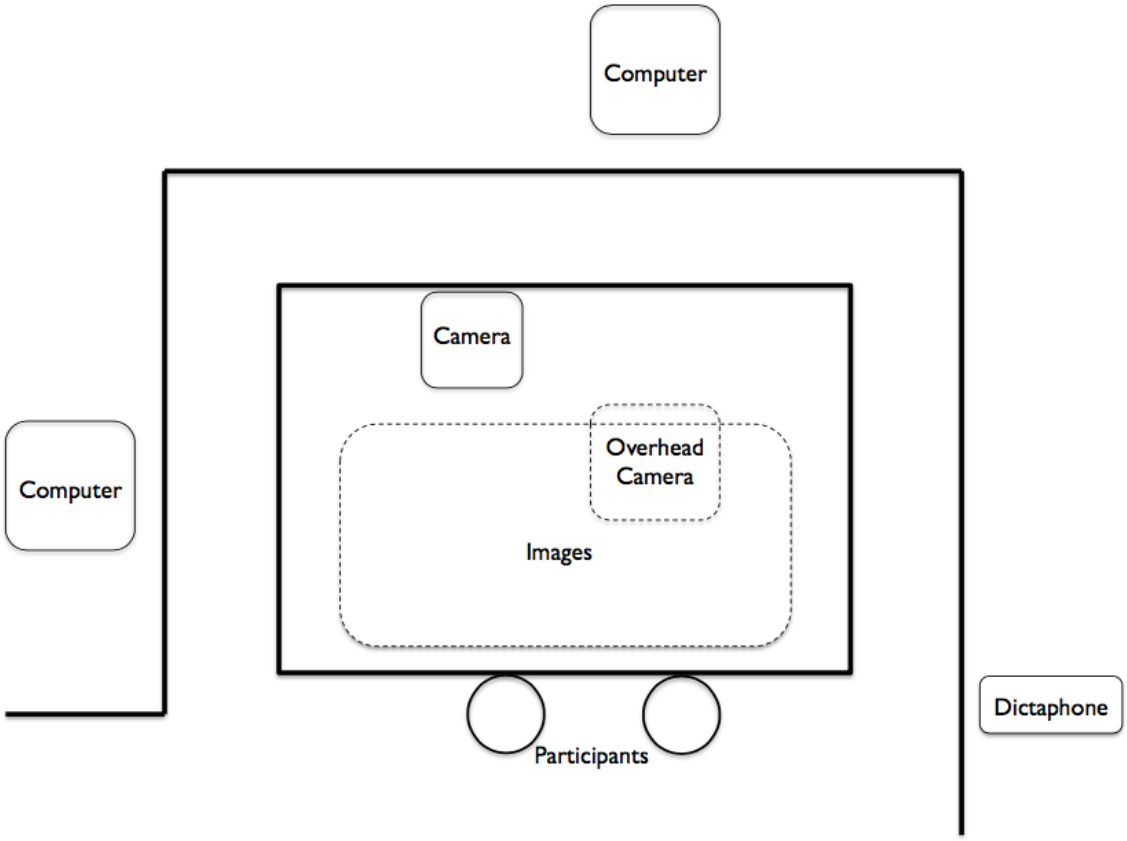


Figure 6.1. Physical laboratory based set up. This diagram show the relative locations of apparatus used in the laboratory stages of the task.

Participants had 15 minutes to order, create and practise their story if they wished. The researcher came back into the room after this time had elapsed unless the participants finished earlier and signalled that they wished to move on. Participants

then told their co-created stories orally to the researcher, indicating which images were relevant to each part of the narrative. It was left up to the participants to decide how they were going to tell the story. The 'performances' of these stories were video recorded, and transcripts of some of these stories can be found in Appendix L. On completion of this task, participants individually indicated which scene they thought was most important and why, using the web application to track whether their views on what is most impactful changed with greater familiarity. While participants were debriefed after finishing the second phase of the task about what to expect regarding the third phase of task, many stopped to give feedback and comments about the task. The findings through these unstructured interviews are also included in the analysis as topics included intentions and conscious strategies, which could only otherwise be inferred from other data collected.

Participants were invited by email to the optional third phase of the task one week later. Here, participants repeated phase one of the study. This phase was delivered by web application off-site and 17 participants completed this section.

This study broadly follows the protocol set out for the FPPT but deviates in the following ways: 1) participants create a story individually during the first stage instead of just familiarising themselves with the images one at a time; 2) participants do not present their story to a fresh audience; and 3) participants have the option to create a second individual story (phase three) at a later point. I asked individuals to construct a story by themselves rather than simply familiarise themselves with the images, and gave them a second opportunity to do so because I wanted to assess whether participants told the same story. Having participants initially construct a story enabled me to understand their initial interpretation of the images in relation to other images. When images are presented singularly, an individual could devise separate thematic stories from each picture. Furthermore, unlike the original FPPT protocol whereby this task is carried out in groups of known individuals, participants were not well known to each other. This decision was made due to ethical concerns regarding the sensitive nature of the images and potential reputational costs to participants. I also did not have participants present their stories to a fresh audience due to logistical constraints, therefore, participants were told that I would be their audience, which may have resulted in some experimenter bias (Lewejohann et al., 2005; Rosenthal and Fode, 1963).

I constructed the protocol above to highlight the different ways the FPPT can be adapted to investigate different types of research question. As such, there are many confounds that are introduced by using different media to tell stories and group sizes to create and re-create the stories across the different phases. It should be noted, that the data generated from this task should not be used as sound evidence to statistically support or reject a hypothesis as these confounds may influence the data. However, the data generated can provide a good indicator of whether there is merit in using this task to answer the research questions stated in section 6.2.2.2. For suggestions about how this task can be operationalised experimentally to investigate different types of research question, please see the general discussion (section 6.5.3).

6.3.4 Data Coding and Transcription

The stories for phase one and three were collected via the web application. I transcribed the recordings of participants' phase two stories and input this data manually into the web application. For the purpose of this study I transcribed content with most 'fillers' omitted from the transcriptions, however, some speech disfluency was recorded. The speech disfluency that is retained pertains to those surrounding interruptions from the other member of the dyad. Although there is literature to support that speech disfluency can be used to signal unfamiliar information (Finlayson and Corley, 2012; Kidd, White and Aslin, 2011), this is not deemed to be important in the absence of a known audience. In phase two, participants occasionally broke from the narrative framework they had set up, in order to give commentary on their story. This too is recorded in the transcripts as well as when participants take character perspectives. An example of phase two transcripts can be found in Appendix L.

As presentation of images was randomised, there is no set 'original' story established, and so content from participants' individual stories is measured on the event level. Here, an event refers to each clause that may include biased information. As such, it is possible for the part of the story that takes place in reference to each image to include multiple instances of multiple biases. Biased information is coded based on the definitions listed in Appendix C. Although cruder than propositional

analysis (Turner and Greene, 1977; Perrig and Kintsch, 1985), this allows us to record multiple relevant content-biased information that may occur in a sentence. This also allows us to assess non-biased stand-alone information that may have been transmitted, for example, using differences in characters' clothing as an indicator of time passing in the stories. As this is a study demonstrating how different types of information can be elicited with a relatively small sample (15 participants completed all three phases), a second coder was deemed unnecessary and I coded all the stories for biased information.

This task elicited a number of variables that have potential for further study including image order, variation and similarities between stories, biased content, most important pictures and spatial layout. There is also great scope for analysis of storyteller behaviours and tools employed to enhance the audience's comprehension. Biased story content in stories from all phases were collated in Microsoft Excel spreadsheets. Phase two order data were initially recorded in Microsoft Excel before being manually inputted into the custom web application. Most data were qualitatively analysed based on observation and data elicited from informal unstructured interviews given as part of debriefing. Any quantitative analysis and data visualisations were created in the R statistical environment using png, ggplot2, dendextend, qgraph packages.

6.4 Results and Discussion

6.4.1 Variation and change over successive iterations of story creation

Considering that participants received the same 16 images, there are over 20 trillion possible permutations for the order in which the images could go. Our participants created 28 unique permutations in phase one (see Figure 6.2) with 26 variants with N=1, one variant with N=2 and one variant with N=3. The total number of unique permutations is high considering our sample size. However, we can also see that some of the differences are very small. The length of the branches in Figure 6.2 show how different stories are from each other. The distances between stories were calculated by comparing the position of each image in the sequence for one participant to the position of the same image in another participant's story. The

dendrogram shows how participants' stories cluster hierarchically. There are three high-level clusters which could be thought of as story 'types' (see below). Figure 6.3 is a heat map of how often each image appeared in a particular position for the stories created in phase one. The darker the square, the more likely the image to appear in this place. We can see from this that there are positions in the story sequence that are more likely for each image. However, we also see that these scenes are not fixed and images were ordered in a range of positions. This suggests that although some positions are more likely than others, our participants are creating different stories even at the level of sequencing events. In Figures 6.2 and 6.3 I include the data for phase one to demonstrate the initial variation in story sequences that can be established with no prior familiarity with the images. We do not include data from phase 2, as this was collected in dyads and therefore the data are duplicated, or phase 3, as this data set is incomplete.

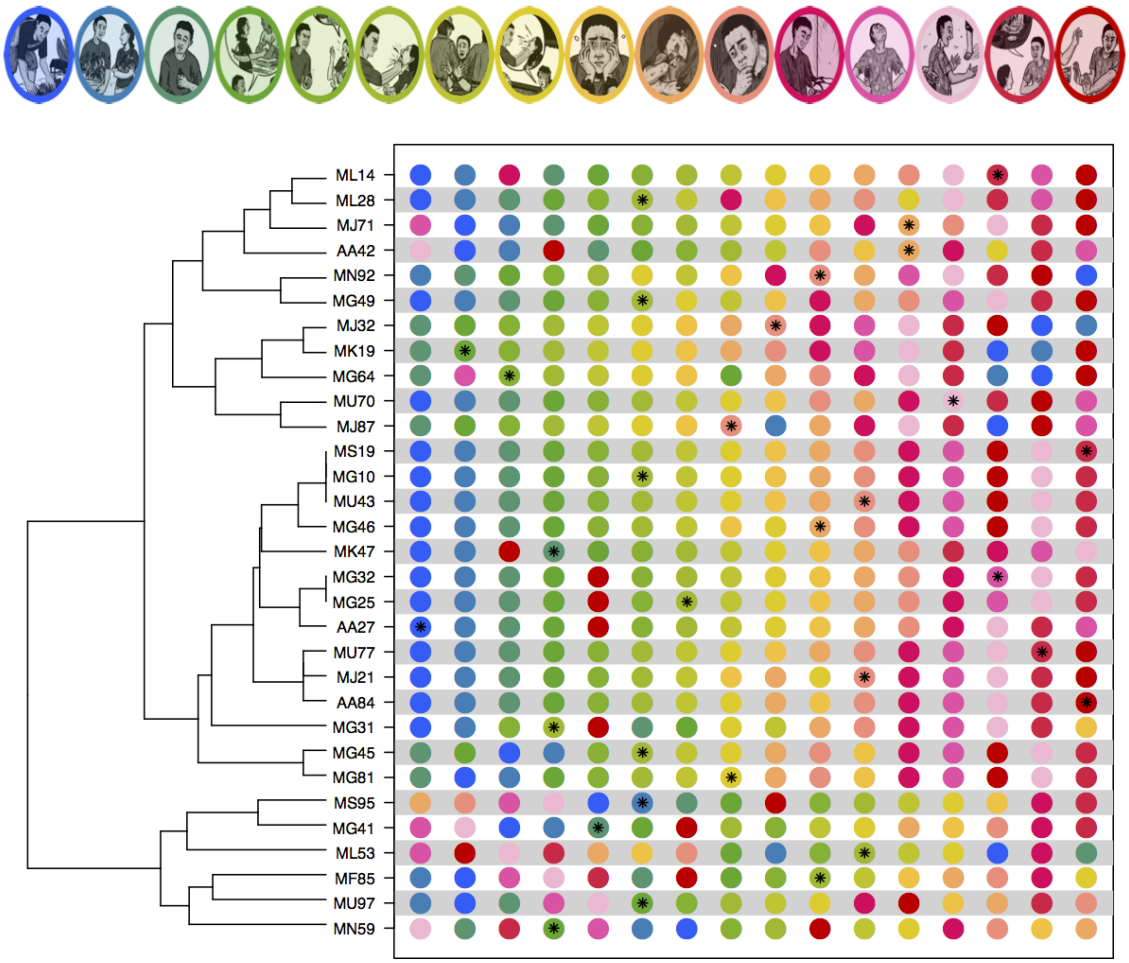


Figure 6.2. Order in which participants sequenced images in their phase 1 individually created stories. Along the top is the canonical order of the story. The asterisk denotes which scene the participant chose as most important. The dendrogram on the left-hand side of the plot shows hierarchical clustering by similarity whereby the shorter the branch length between two stories, the more similar they are. Each branch end of the dendrogram denotes a unique story order permutation of which there are 28 in total.

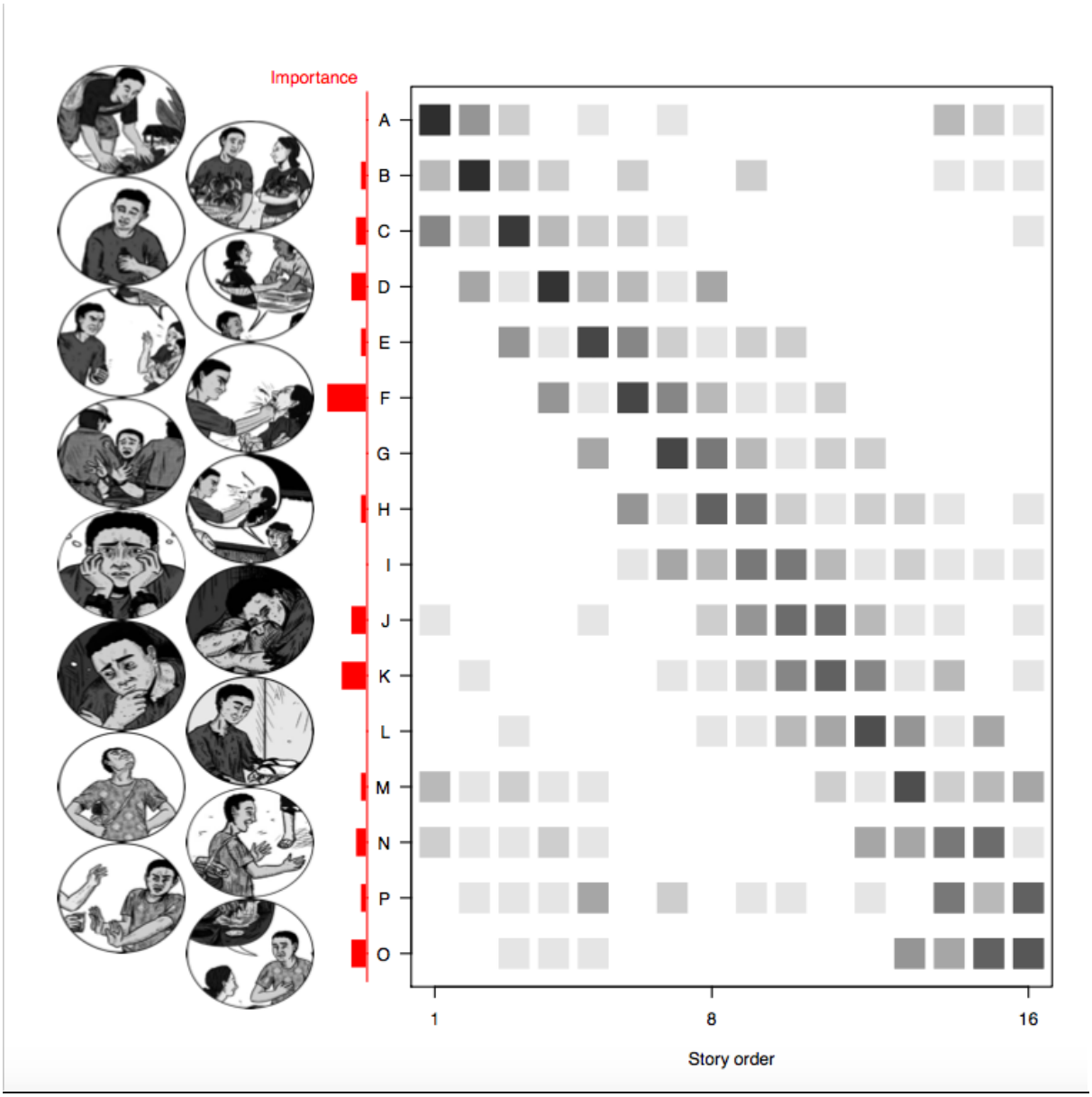


Figure 6.3. Heat map showing the distribution of positions in which participant selected each picture in their stories for phase 1. The darker the square, the more participants chose that position for each image. To the left of the heat map, the red distribution shows which images were chosen as the most important scene in the story. Letters refer to the canonical order.

With each iteration we expect stories to change, as memory is imperfect and each story is an opportunity for innovation. This task introduces an extra intervention through the co-created story. In phase two, all participants discussed their previous stories; therefore, they have to negotiate co-creating a narrative with prior knowledge of two potential stories. Story distances were calculated by giving a score to each story image based on deviations from the position of the same image in the order created by the other member of the dyad. As sample size is different across phases and variances are unequal, I carried out Welch's t-test between all phases of

the study. I found significant differences between means for the first and second phase [$t(233.63) = 13.892$, $p < 0.01$] and for the second and third phase [$t(318.9) = -11.504$, $p < 0.01$]. However, there was no significant difference between the means for the first and third phase [$t(499.13) = 0.466$, $p = 0.6412$]. This suggests that stories are changing over each iteration but there is greater variation in phases one and two.

Figure 6.4 shows how similar participants' stories are to each other and whether this is mediated by the stories created by their partner in phase two. By altering the group dynamic for creating a story by partnering the participants, the task no longer is a simple study of repeating storytelling. Instead the task now allows for negotiation between partners and exposure to other variants of the story. One might expect model-based biases such as prestige to influence the decision-making process (Atkisson, Mesoudi and O'Brien, 2012; Henrich and Gil-White, 2001). Although I do not measure prestige here, Figure 6.4 shows any imbalances in order sequence retained from previous iterations. For example, for dyad MG64/MG45 (second on line two), we can see the phase two co-created story was slightly more like MG45's phase one story (there is a darker line between P1B and P2). MG64's phase three story was more similar to the phase two story and MG45's phase one story than to their own (MG64's) original story. This suggests that MG45's original story had a greater influence on the final outcome of MG64's story than what was drawn from their own individually created story. If we were to look at ML28/AA27's stories (third on line three), we can see that the phase two story is equally similar to their original stories and both of their phase three stories are more like their co-created story (P2) than their initial individually created stories. The graph also shows relative imbalances between participants as they co-create their stories. For example, it is clear that one participant in the ML14/ML53 dyad (fourth on line three) has a maximally similar story order in phases one and two, suggesting that they are likely identical. However, the second participant is linked by very light grey lines, which suggests that it sits at an almost intermediate point between being maximally different and maximally similar to other stories (there would be no line if it sat at the intermediate point). Other dyads such as MG10/AA84 show relatively little change in order across individual creation and co-creation

condition but the graph suggests there was little difference between their original stories.

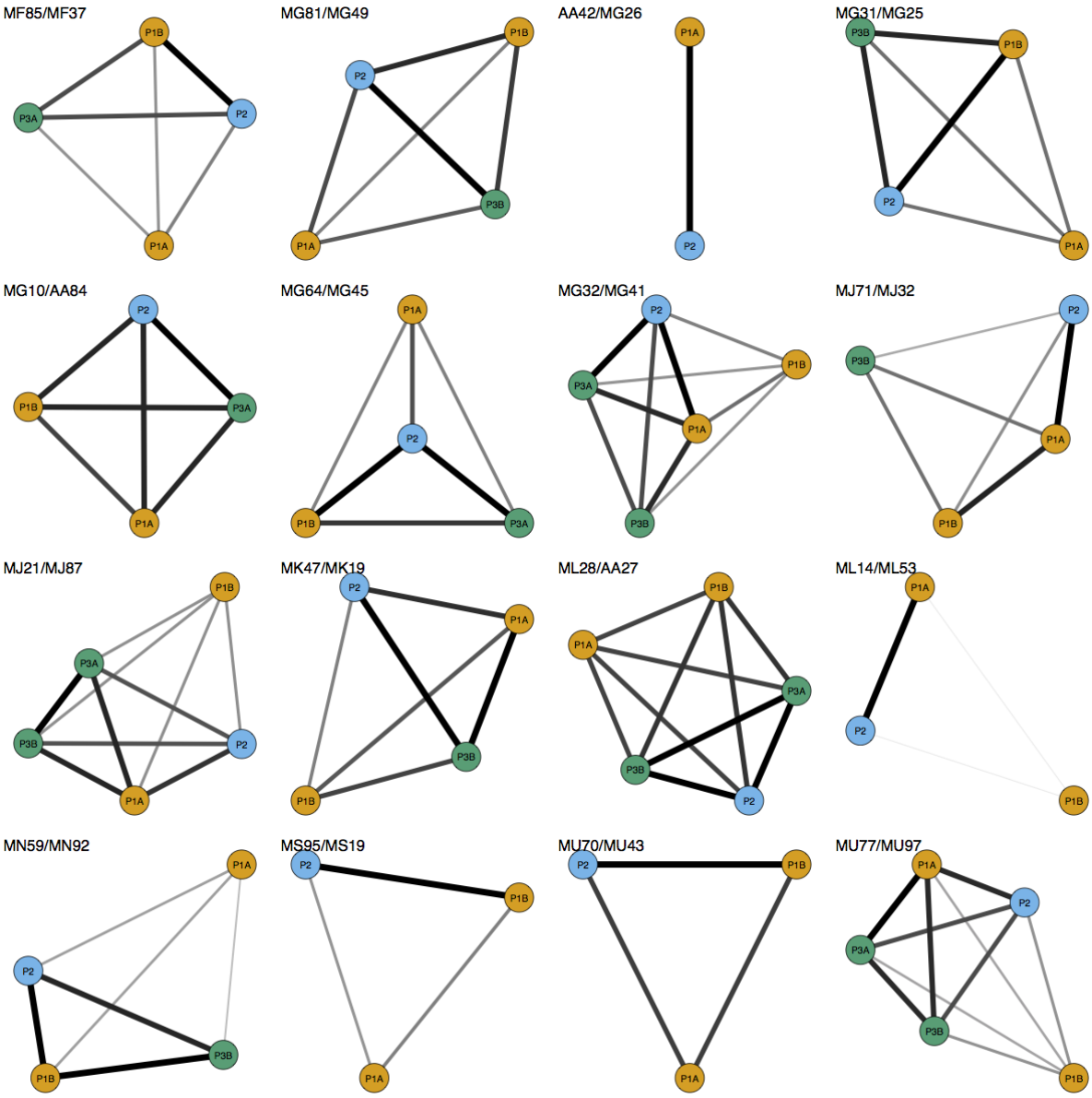


Figure 6. 4. Relative distances between stories for each participant. Orange circles relate to phase 1 data, blue circles to phase 2 data and green circles for phase 3 data. Not all participants completed phase 3. Nodes are laid out spatially to capture distance using a 'spring' model therefore there is no scale or neutral point of reference. Black lines show similarity between stories whilst grey lines signify difference. The weight of the lines signifies the strength of the similarity or difference.

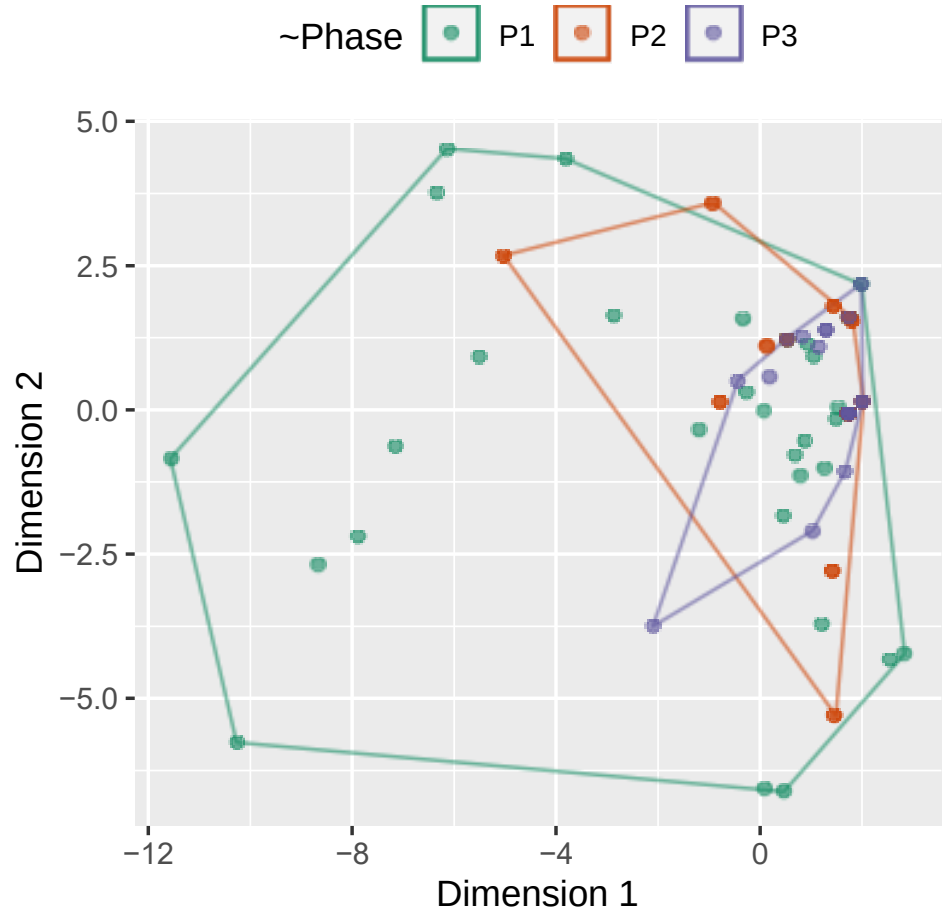


Figure 6.5. Multidimensional scale plot showing distribution of story distances for all stories across all phases.

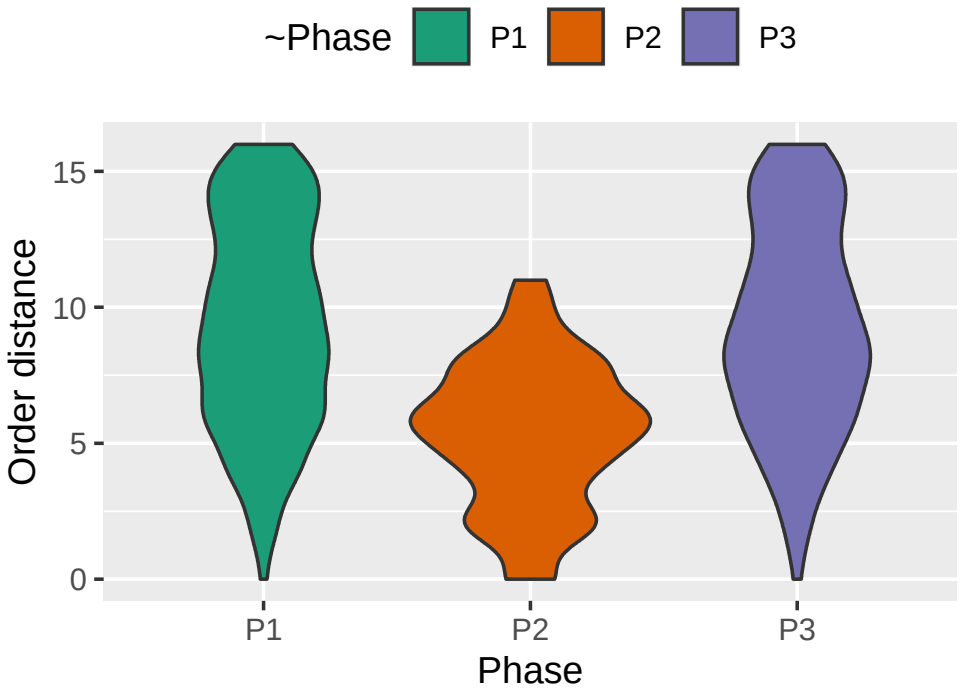


Figure 6.6. Frequency distribution plot of order distances between all stories for all phases.

By using multidimensional scaling to compress the order distance to plot data along the two 'most important' dimensions we can see how the stories cluster within the same space (Figure 6.5). With greater familiarity story sequences tend to converge. However, this may also be an artefact of fewer stories generated in phases two and three. I carried out Welch's t-tests between the means of phases one and two [$t(448.89) = -0.946$, $p = 0.345$], phases two and three [$t(505.98) = 1.400$, $p = 0.163$], and phases one and three [$t(491,59) = 0.717$, $p = 0.474$]. Welch's t-test for the multi-dimensional scaled data showed no significant differences between means for any of the phases.

When plotting the frequency distribution of the actual distance between stories (Figure 6.6), we can see that the image orders are distributed similarly between the first and third phases, and phase two is more clustered. This suggests that there is greater variation in phases one and three. This might be attributed to either differences in group size (individual vs. pair), as creativity may be more constrained by co-creating stories; or by mode of storytelling. Although collaboration usually leads to greater creativity (Lwin, 2017; Rojas-Drummond, Albarrán and Littleton, 2008; Sawyer and DeZutter, 2009), this is usually in the detail. The story sequence is a cruder measure and we may find greater clustering to appeal to individuals' shared understanding of the story schema (McVee, Dunsmore and Gavelek, 2005). The oral phase two allows participants a full fifteen minutes to order and reorder their images as necessary, but written phases one and three had participants order their story first before writing their story. Both of these tasks had to be completed within the fifteen minutes and, as there was no possibility to edit the order of images, the time spent ordering the images may have been more limited.

From these data we can see that there are variations in how participants sequence stories in individual and paired conditions. I have established that there may be different dynamics between pairs (Figure 6.2), and the clustering of sequences in phase two (Figure 6.6) suggests that individuals may be more likely to conform to norms in the presence of others (McDonald and Crandall, 2015). However, this might be due to confounds in the modality of storytelling. These results demonstrate that there might be fruitful application of the FPPT to studying

group dynamics and modes of storytelling by creating experiments with conditions testing each hypothesis separately.

6.4.2 Transforming content

Stories created in all phases were coded for biased content (see Appendix C). I coded for all instances of biased content including social, gossip, emotional, survival, counterintuitive and rational biases in each scene to get a raw score for how many biased elements were present in the stories (see section 6.3.4). I opted not to record a binary presence or absence of biased content in each scene. Instead, I chose to record the variation in volume of content rather than just the types of content included. For example, the sentence "He greets his family happily after missing them" (MG31, phase 1) would contain two social elements (greeting, kin relationship), one positive element (happily) and one negative element (missing them). I have not included statistical analysis comparing the mean number of biased elements between phases as the sample size is too small to be meaningful, due to the second phase halving the number of stories and not all participants completing phase three. We can see in Table 6.2 and Figure 6.5 that phases two and three included more biased content than phase one but for many participants this is because they did not complete their first story.

We would expect more content in longer stories, but I do not control for this because it allows us to understand the communicative cost based on time pressures. In phase two, participants had an unlimited time to tell their story and, on completion, were given the opportunity to include anything else they wanted to add to their story. All participants chose not to include any additional information, suggesting that data from this phase are a true representation of what participants *choose* to tell.

Social, moral and negative information is highly represented across all stories (Figure 6.5), which is constrained by the images set. Unlike the creation stories used in Chapter 5, which contained social, survival, emotional, moral, counterintuitive and rational information, the stories created by our participants in the FPPT were more limited in biased content (see Table 6.2, Figure 6.5 and Appendix M). This is likely because their stories were constrained by the images and our participants did

not deviate from what was depicted even though they had the opportunity to do so. Whereas in our previous transmission study (Chapter 5) we did not find moral information to be specifically retained, the images here specifically depict punishment for deviation from social norms and so this type of content is prevalent across all stories. Story content seems to depend on genre; if we had asked our participants to construct a creation story based on the FPPT images we would likely find the counterintuitive information that we do not see in our participants' constructed narratives.

Using the FPPT we are able to track the presence of biased information in stories across all phases. From these data I infer that biased content increases with greater familiarity with the material. However, this might also be an artefact of changing modality of storytelling. Future research using this task should allow unlimited time to tell the story to ensure that all information is recorded.

Table 6.2. Summary table showing the average number of biased elements per story across all phases. Fewer stories were submitted for the third phase (N=15).

	Individual condition (Phase 1)		Dyad condition (Phase 2)		Individual condition (Phase 3)	
Biases	Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
Social	20.46	8.16	27.06	9.73	22.4	7.05
Gossip	1.19	0.82	1.31	0.47	1.27	0.70
Survival	1.66	1.26	1.50	0.88	1.80	1.26
Emotional (Positive)	1.84	1.69	2.81	1.31	1.67	1.50
Emotional (Negative)	6.56	4.47	8.69	3.00	7.20	2.18
Moral	5.50	3.16	8.25	2.60	5.87	1.64
Counterintuitive	0.00	0.00	0.00	0.00	0.00	0.00
Rational	0.65	1.10	1.125	1.18	0.47	0.83

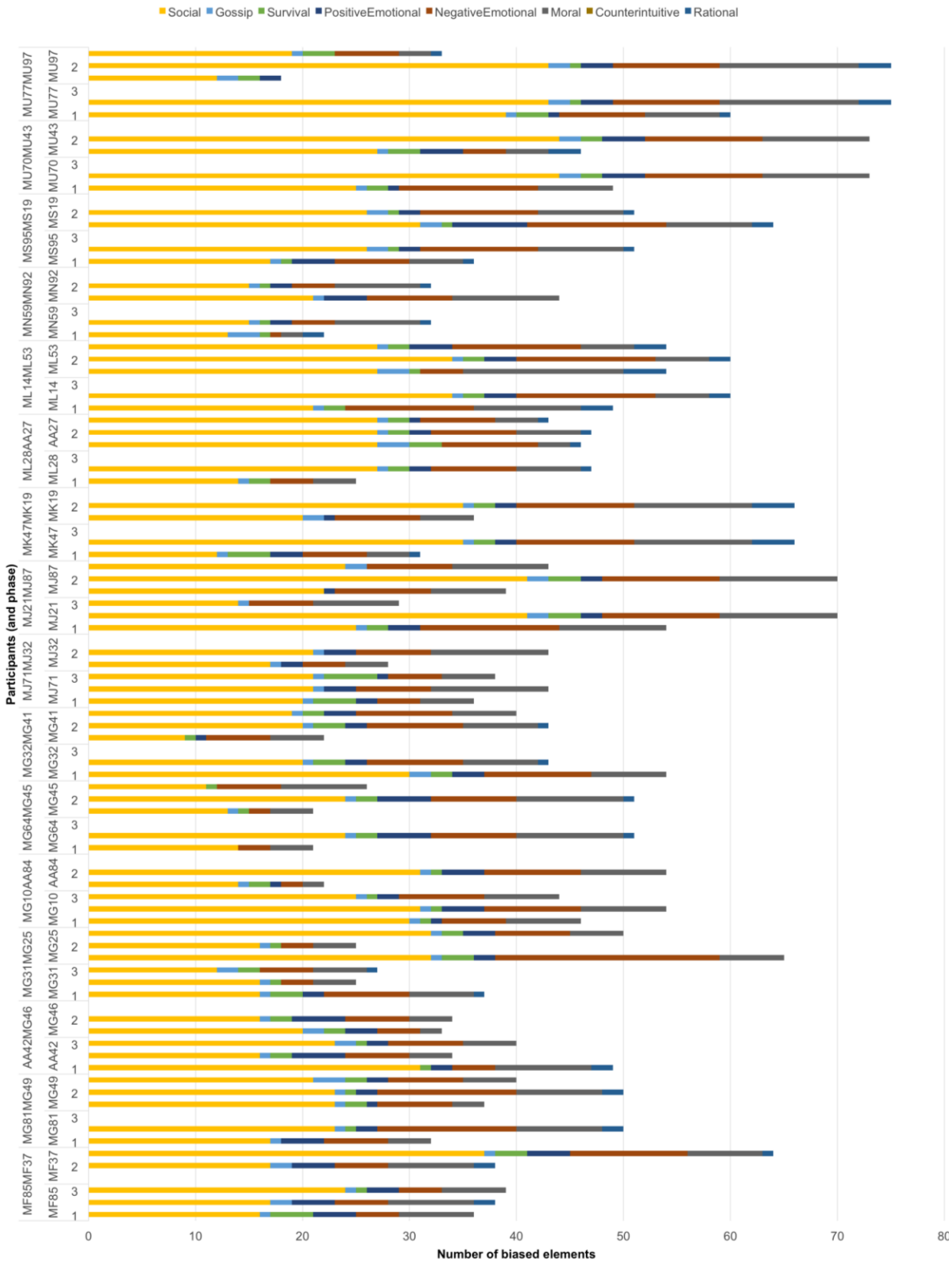


Figure 6.7. Proportions of biased information change over storytelling phases. Bars show the total number of biased elements split into biased categories. For each participant, the bottom bar relates to their phase one story, the middle bar to their phase two story and the top bar to their phase three story. Phase two stories tend to have the most content but social, negative and moral information is consistently present.

6.4.3 Signalling importance

Although stories vary, we see that information that is considered important is transmitted. In the absence of selection biases, we would expect participants to randomly choose which scene is more important. Using the distribution of most important scenes chosen in phase one by our participants, we would expect three people and no more than 10 people out of 32 (if the task was repeated 10,000 times) to choose the same scene twice in a row as most important. However, we observe that 7/15 participants (who completed all phases of the study) choose the same scene. This is scaled up to 14 out of 32 participants, which is much greater than the expected distribution (Figure 6.6). This suggests that, despite variation, important content is stable. Table 6.3 shows which images (numbered based on presentation order) are deemed most important for all participants across all phases. Between phase one and two we also see that 13 people chose the same image as the most important scene. This also suggests that, despite variation, important content is stable.

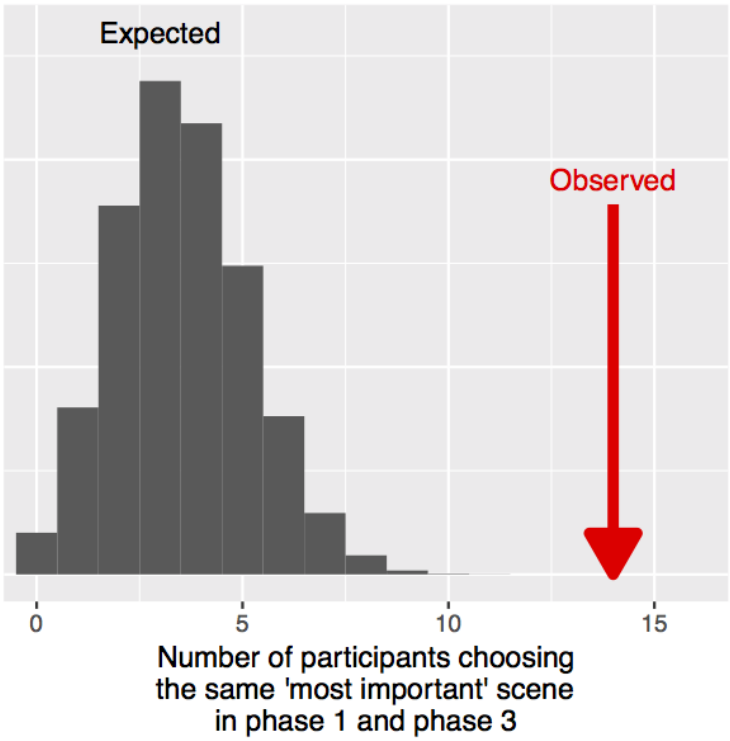


Figure 6.8. Expected (over 10,000 iterations) and observed distribution of participants choosing the same 'most important' scene. Two 'most important' scenes from the first phase data were sampled 35 times to count how many of the pairs were the same. This in turn was repeated 10,000 times to get the expected distribution.

Table 6.3. Most important scene chosen by each participant for each phase. Numbers refer to the presentation order number (which was the same for all participants). Images that were selected multiple times by participants across phases are highlighted in bold.

	Most important scene		
Participant ID	Phase 1	Phase 2	Phase 3
MF85	**12**	**12**	**12**
MG81	5	11	N/A
AA42	**3**	16	**3**
MG31	**12**	**12**	**12**
MG10	**12**	**12**	**12**
MG64	**15**	**15**	N/A
MG32	14	5	N/A
MJ71	3	4	13
MJ21	**16**	**16**	**16**
MK47	7	10	N/A
ML28	**12**	**12**	N/A
ML14	13	10	N/A
MN59	4	15	N/A
MS95	6	12	N/A
MU70	1	13	N/A
MU77	**13**	**13**	N/A
MF37	6	16	12
MG49	**12**	**12**	**12**
MG46	3	16	N.A
MG25	**12**	**12**	**12**
AA84	11	N/A	N/A
MG45	**12**	**12**	**12**
MG41	7	16	11
MJ32	**16**	**16**	N/A
MJ87	16	3	8
MK19	4	10	N/A
AA27	1	**13**	**13**
ML53	**12**	**12**	10
MN92	16	11	N/A
MS19	**13**	**13**	N/A
MU43	16	13	N/A
MU97	4	7	16

There are many different strategies by which participants signal importance. All participants were instructed to indicate, as they narrated their co-created story, to which image each part related. This varied from passive cues such as gaze and pointing at images to actively handling images, and participants often used a mixture of these approaches. These strategies are in line with stimulus enhancement, whereby attention is drawn to the stimulus material to scaffold social learning (Charman and Huang, 2002; Heyes et al., 2000; Rendell et al., 2011). The variation in indication demonstrates other approaches we may use to signal information that we might deem important. For example, many participants pointed to particular parts of images to highlight a particular feature or character to which they were referring. Gesture can be used to scaffold content being transmitted verbally and has been well documented in the education literature (Church, Ayman-Nolley and Mahootian, 2004; Goldin-Meadow, 2014; Kelly, Manning and Rodak, 2008). This may also have been exaggerated by the researcher acting as the audience, whereby participants were keen to show their process in devising their stories as a form of demand characteristic (Orne, 1962).

Many participants used metacommentary during their stories to explain what was happening in the story and why they had portrayed this that way. This is much more common in the oral condition than in the phase one and three written narratives, suggesting that oral transmission is a more flexible domain for demonstrating different perspectives between characters, narration and storytelling. One dyad (MJ21/MJ87) explicitly signalled what they considered to be the most important aspect of their co-created story by titling their narrative: *The Redemption*. By titling the narrative, this not only signals what the story is about but the type of story this is (i.e. the audience knows to expect a structured narrative as opposed to an anecdote, and their attention is captured). Even within academic literature an article with a title that catches attention, perhaps through humour (Sagi and Yechiam, 2008) or by being informational (Paiva, Lima and Paiva, 2012), receives more citations.

The next section will address some of the themes that have come out of the previous cross-cultural studies and features of storytelling that have arisen from this specific task implementation.

6.4.4 Storytelling effects

6.4.4.1 Storytelling performance

The success rate for completing a narrative varied across written and verbal storytelling performance. For both individual written and group oral conditions, participants had fifteen minutes to order and devise their stories. In phase one of the task only eight out of 32 participants did not time out, with 18 reaching the final scene. Participants were aware of their time frame and we would expect that if participants were motivated to pass on relevant information they should focus on completing the story, efficiently transmitting only the most relevant information. Some do, yet others focus more on the storytelling aspect of the task, trying to create a quality narrative. For example, participant MG25 reached scene 12 and rationalised that they were taking the narrative aspect seriously (MG25, 2019). Indeed, their story is one of the richest of them all; yet, the co-created narrative was one of shortest. The phase three story is complete and some detail is sacrificed compared to the first story, suggesting that a different strategy is being deployed whereby communication of all major events is prioritised over narrative richness (see MG25, Appendix K).

The time constraint that participants had for phase one meant that, in phase two, participants found new details that had been missed and shared details of their original stories in their discussion to create richer oral stories. All participants completed their oral compositions (phase two) within the set timeframe. Many finished earlier (9/16). This is likely due to familiarity with the images and because speech processing is quicker than writing. Here we see a trade-off between modes of communication: oral transmission allowed greater efficiency for narrative composition than written modes. However, there were inconsistencies in storylines in oral conditions due to the ephemeral nature of oral transmission; with a written story one can refer back to previous narrative to ensure coherency.

There is also variation in performance in storytelling itself. Participants used different techniques to tell their group stories, from factual reporting of events to roleplaying. Most pairs discussed previously how they were to tell their stories and stuck to these plans, either taking turns for particular sections or images or

assigning characters' roles to each storyteller. A few pairs (3/16) used the opportunity to tell the story together without clear delineation of sections, interjecting to give support or clarification to the primary storyteller at the time. There was variation in reporting style, some choosing to remain as narrators and others taking on the perspective of characters in the story. Again, these different methods suit different functions of storytelling: whilst the roleplaying was certainly more entertaining, factual reporting may also be an efficient form of information transfer (Krause and Rucker, 2020). How participants performed their oral composition is constrained by audience. Graesser et al.'s (2002) constructionist theory implies that participants will create their narrative based on the needs of the audience, which in this case was the researcher. Considering that many participants were interested in establishing whether there was a 'correct' order, we can reason that participants were making assumptions about the nature of the study.

Participants may have diverged in their performance styles due to their expectations of what the researcher wanted and the familiarity the researcher has with the images. This demand characteristic, whereby participants assume the experimenter's purpose and adapt their behaviour to fit that interpretation, may have caused participants to exaggerate and signpost their explanations beyond what they would for a fresh audience (Nichols and Maner, 2008). For example, those who believed that the elicitation task was about identifying the content of images may have created a linear factual account, whilst those who assumed knowledge of the images on the part of the researcher could create richer, more cognitively demanding narratives. In this case, we would have to conservatively interpret the findings of this study and the intentions of the participants. However, if these results are subject to demand characteristics, we could also interpret the data to be the result of audience engagement. In all phases of the task, participants were told to "tell *me* a story", establishing a known audience for each participant. Adapting behaviour (e.g. the variation in storytelling style) to suit the researcher also demonstrates how participants may adapt their behaviour to engage with their audience and to enable comprehension of storyteller intent (Graesser, Olde and Klettke, 2002).

6.4.4.2 Identifying characters and pronoun usage

Participants took different approaches to 'casting'[8] their stories. This is highly important as this provides the referential system (level 5 of Graesser et al.'s (2012) model for structuring stories) for the audience to understand the events that occur.

All participants determined some social relationship between the male and female protagonists (either as spouses or partners), and the child as belonging to them. There is variation in the social relationships of the secondary characters. Where characters are given specific identities, they are kin-based. Notably, the old man who witnesses the assault is often identified, usually as the woman's father but sometimes the man's father but never as the child's grandfather. Variation here is unsurprising as ambi- and neo-locality[9] is common in the UK. Although a kin-based relationship is established here, it is rarely commented on beyond an initial identification.

Other kin-based relationships have been established in these stories. One dyad (see Appendix L) chose to make the story about the man talking about his brother to his family and friends. In phase two they constructed a story with a moral message about being grateful for what you have. In their story they presented the protagonist as a man relating the misdeeds of his brother and his subsequent imprisonment. By doing so, they cast the man and woman in the images as two separate characters each: the man telling the story and his wife; and the brother who drank and punched the sister-in-law. In their discussion, participant MJ71 commented that the men have to be brothers who either married sisters or women who look remarkably like each other (MJ71, 2019) to justify the casting of multiple roles.

A minority of participants identified characters in the group drinking scene as kin. MJ21 identified the man relating gossip as a cousin because "there's like that level of trust…or maybe his brother" (MJ21, 2019). Here we see the justification of

[8] Participants cast the story by imbuing people in the images with characteristics and traits to develop their character. As a play requires actors, the participants create characters for the stories.

[9] Ambilocality is where a couple lives with or near either spouse's parents post marriage. Neolocality is where a couple finds their own residence independent of family from either side.

the blind acceptance of gossip because of a shared close relationship. This demonstrates that there is greater trust amongst kin that if this was just a friend or a stranger.

"So, are we giving them names?" (MG41, 2019,) was a common question discussed by participants. This often came up as a default convention to be addressed. A quarter of dyads named their main characters; more discussed naming but did not settle on names. Those who named characters used it as a device to add depth to the story and to help identify characters: on discussing names, participant MK47 remarks, "Are we giving them names?... I found it really hard to tell actually without giving them names...I found it so hard to write about without being able to refer back to characters but it might be easier speaking about it actually" (MK47, 2019). In this case, names were not included; however, if names were used, they were not used throughout. The majority of participants defaulted to pronouns or referred to the characters as a 'man' or 'woman' or by their relationships to other characters. For those participants who discussed character names but did not use them, they either decided against use because they deemed it unnecessary, or because of the nature of their story. Although the characters are designed to be ethnically ambiguous, two participants made comments regarding their perceived ethnicity, and one did not want to implicate that cultural group in a story about drink and assault. MK19 chose not to identify the characters saying: "I was worried… as they are very obviously Pacific Islanders" (MK19, 2019). Naming conventions are not critical to the transmission of information but some seem to use it as another device to make stories more interesting and potentially memorable, acting as a referential signal. Participants also struggled to come up with names if they decided to use them, and we have seen in our previous study (Chapter 5) names are often misremembered or usage declines.

6.4.4.3 Social norms and cross-cultural comparisons

Previous implementations of the task show that the stories created are culturally constrained and this application is no exception. As WEIRD designers created this task, participants (also WEIRD) interpreted images in line with the original story

design. Participants adhered to social conventions regarding social identity and stories were primarily constrained by social norms regarding punitive scenes (level 3 of Graesser et al.'s (2012) model for structuring stories).

The sensitive subject matter was unexpected for some participants and discussions were peppered with nervous laughter and rationalisations about how this sequence of events came about. There are many morally problematic aspects that can be drawn from these images: adultery, gossip, alcoholism, abuse, and police brutality. All participants condemned the abusive behaviour, however, all participants focused on drinking as *the* morally reprehensible behaviour to be righted. Many participants directly attributed the misplaced anger as being a direct outcome of drinking in an attempt to justify the abusive action. The UK is known for having a culture of drinking (McArdle, 2008; Plant and Plant, 2006; Viner and Taylor, 2007) and all participants identified the contents of the bottles as alcohol. Many participants also drew attention to bottles present in non-drinking scenes, whether they were intact or smashed, and whether they were in hand or not. This suggests that bottles were a particularly salient prompt for UK participants in these pictures. This is a stark contrast from the Lamjung Yolmo speakers who interpreted the bottles as medicine since alcohol is an unfamiliar substance (San Roque et al., 2012).

UK participants were also very detail oriented. Participants were particularly attuned to items of clothing worn by characters, using this feature as a cue of time passing. Some participants grouped images together on this basis, despite knowing that clothes can be worn on multiple separate occasions, because they believed that the detail was crucial to the design of the original story. Whereas many of our participants used clothes to signal time passing, there is also cultural variation in how we interpreted the characters based on clothes. All participants identified the uniformed figure in picture 2 as a police officer or guard. Awiakay participants have previously interpreted this figure as a teacher as he is wearing 'smart' clothes (San Roque et al., 2012).

Although stories and storytelling are common activities carried out in schools in the UK (Baldwin and Dudding, 2007; Benford et al., 2000; Daniel, 2012; Parry, 2010), this task is relatively unfamiliar. Storytelling in this format is rarely carried out by adults and, instead of using the picture to serve as creative inspiration, many

participants presented 'factual accounts' of events occurring in each picture. This is partially due to the design of the task, with one participant remarking upon leaving that they were surprised at the content of the pictures assuming that task would be less structured and expecting more general images (e.g. a tree) (MK47, 2019).

Stories are constrained by cultural norms regarding what a story is. When this task has been previously carried out with Lamjung Yolmo and Awiakay speakers, participants refused to combine all pictures into one linear story, opting to have multiple stories or even create a separate story for each image (San Roque et al., 2012). By contrast, our participants incorporated features that are common in literary tales in English including opening and ending markers (e.g. 'Once upon a time', 'The End''), grouping events into chapters and acts (while still attempting to create a single narrative), and creating titles to signal the content and cue attention. Participants also signalled deviations from linear storylines and gave reasons for the digressions (e.g. telling the researcher that they needed to use a picture again because the story was a flashback). All these features are prompts for the audience so they are more receptive to information specific to the genre, which has been shown in survival narratives (Kroneisen and Erdfelder, 2011).

6.4.4.4 Image layout

There is variation in how participants oriented images in space (see Figure 6.7). Most participants ordered the images linearly from left to right, as we would expect based on English writing conventions. When images were put into a grid format, the majority placed them primarily from left to right and secondarily from top to bottom, in keeping with Western comic book formats (Cao, Chan and Lau, 2012; Jing et al., 2015). This type of orderly layout is ideal for logical story sequences to promote an "informative ambience" (Murakami and Bryce, 2009, p.51).

However, some participants grouped certain images together. Participant MK47 described how their dyad grouped images around central events or 'chapters', an obvious reference to the extent to which storytelling is bound to the literary story. Some participants also used the layout of the images to distinguish parallel timelines (or flashbacks) and different perspectives (see Figure 6.7c) as has been

established in the graphic literature as a way to demarcate episodes or subplots (Bateman et al., 2017). All participants who created a non-linear storyline provided metacommentary to explain what was happening; however, most written narratives followed a chronological order. This suggests that the ability to encode different levels of information (also see section 6.4.5 on signalling importance) is an additional benefit to oral transmission over written modes, and this additional scaffold may explain how oral variations of stories reach stability and endure.

Figure 6.9. Different image layouts participants used to organise their stories: a) linear; b) grid; and c) chapter.

6.5 General Discussion

6.5.1 How does story construction vary?

Even within the scope of this study, we can see great variation within the narratives that are created. A number of participants discussed whether there was an 'original' story in mind when the images were illustrated, and more importantly whether there was a 'correct' order. There is a canonical order suggested by the original design of the task (San Roque et al., 2012; see Table 6.1), which is broadly followed by our participants, as can be seen in Figure 6.3. Despite being told that these images could go in any order and should serve as inspiration, the majority of participants ended up ordering the images in a similar fashion.

A common motif within the co-created stories was a redemption arc, whereby the male protagonist assaults the female protagonist after drinking and realises 'the error of his ways' whilst imprisoned. Upon release from prison and returning home, the male protagonist renounces drink. Many participants stressed the moral message associated with this story referring to 'lessons learnt'. The moral often came at the end of a story, as is common with parables and fables (Beavis, 1990; Hunt, 2009), with participants either portraying the character rejecting alcohol with direct speech or by signalling the moral using tone and words to the effect of "…one thing's for certain is that he's never going to drink alcohol again…" (MG49, 2019).

This is unsurprising considering we also see that many of the phase one stories also have this redemption arc (Figure 6.2). Figure 6.2 shows that phase one stories split into three main categories: the top branch tends to follow a 'happy ending' structure; the second main branch are variations that are closer to the canonical order; and in the bottom branch participants create stories that are very different to other participants. With the exception of stories in the bottom branch, the stories manifest the redemption arc. These results suggest that although there is much variation, the variations themselves are superficial, not greatly changing the nature of the story.

I also found variation in stories framed. Although participants were warned in phase one of the restrictions, participants spent on average 5 minutes and 53

seconds (SD = 1 minutes 56.18 seconds) viewing and ordering the pictures in phase one. In phase three, participants spent considerably less time sequencing the images (average = 2 minutes and 42 seconds, SD = 1 minute 11.02 seconds), which is likely due to greater familiarity with the images. Despite spending a third of the allotted time ordering the images in phase one, many participants commented that, when they had begun to write their narrative, they would have liked to change the sequence of the images. Participants MS95 and MS19 both noted that their choice of order in phase one stemmed from the first image they saw – they chose this image as their starting point and spun their narratives from there. Indeed, MS95 created a story that was dissimilar to other participants but MS19 still created a story in line with the canonical order (see Figure 6.2). In all phases, participants sequenced the images first and could not change this order, therefore, had to use different strategies to create coherent narratives. A separate pair (MK47/MK19), upon recognising that the images presented in the group task were the same as the individual task, used a similar strategy as an opportunity 'to be creative'. Participants MK47 and MK19 chose two images at random to be their starting and ending point and fashioned the rest of the story based on this proviso.

Where others came across difficulties in sticking to their decided order, this was often resolved by creating parallel timelines or storylines. For example, in AA42 and MG46's shared story, they started with the 'family talking' image and referred back to this image towards the end, framing the main story as a flashback until time caught up with the present (see AA42/MG46, Appendix L). Some dyads avoided the traditional linear temporal sequence that is common in narratives (Mishler, 1995), moving between storylines (see MJ71/MJ32, Appendix L). However, even in modular event-based stories, all group-constructed stories were informed by some sort of temporal theory determined by characters' clothing or relative age, such as the child appearing older and taller in the 'homecoming' scene than in the 'punching' scene (see ML53, Appendix K). In turn this suggests that narrative construction amongst English speakers is partially driven by temporal factors, even if it is not performed explicitly.

Participants demonstrated great variation in both their content and framing of the stories, despite being restricted by image content. Multiple content biases are present in these narratives but we do see increases in the types of content

presented. For example, all participants mention some form of plant cultivation but there is variation in whether this refers to gardening (non-survival information) or farming (survival information). The range of variation might demonstrate how both content bias (Boyd and Richerson, 1985; Richerson and Boyd, 2005; Kendal et al., 2018) and cognitive attractor theory (Claidière, Scott-Phillips and Sperber, 2014; Sperber, 1996; Sperber and Hirschfeld, 2004; Claidière and Sperber, 2007) both work. Many participants independently converged on similar stories when generating the material themselves, which we might attribute to 'cultural attractors' (Buskell, 2017). However, I observed that phase two stories often had a mediating effect on phase three stories, which we might expect if using a 'content bias' framework. In the absence of other variants to sample, participants may rely on attractive domains; however, content biases might become a more popular strategy when multiple variants are made available. Other factors may also contribute to this variance: model-based effects were not accounted for (beyond controlling for gender) and this could also influence what is expressed.

The most important finding from this study is that although the narratives are transformed, we can see certain types of genre-specific information is conserved (i.e. social, moral and negative information). Whilst it may not be important whether the fact that a character is wearing shorts in one scene and trousers in the next is indicative of different days, participants still retain what they think is significant in these stories. Indeed, we see that in 75% cases, co-creators differ in what they consider to be the most important scene (level 4 of Graesser et al.'s (2012) model for structuring stories), despite both of them agreeing on a set story. This demonstrates how multiple interpretations or mental representations can be evoked from the same stimulus material, but also suggests that from the same narrative, individuals may prioritise different information. From this study it is uncertain whether participants are driven by a need to transmit information. However, this task can be operationalised to study storyteller choice by priming participants to create a story that will seed a transmission chain. Transmission could be motivated by incentivising recall of stories in later generations.

6.5.2 What do these findings add to cross-cultural research?

The results that come out from this study are specific to English speakers but, as English is spoken widely across the world; we have not limited participants to those born in the UK. This adds a complex confound to our data as we expect stories to be culturally constrained as well as potentially linguistically constrained. However, as all participants are based in the UK and proficient in English we assume that this sample is representative of adaptation where necessary to UK cultural norms.

We do see adherence to UK cultural norms in terms of social relationships, social justifications (i.e. abuse is punished even when mediated by alcohol) and more basic graphical conventions. We can see the effect of the literary story and other narrative conventions, which appear in our participants' co-created stories: the organisation of images into chapters; the beginning of a story with "Once upon a time…" (MU43, 2019); and the ending of a story with "Scene" (MG46, 2019) in roleplaying narratives. These features have not been reported in other applications of this task suggesting that they are narrative features which are culture specific.

Trying to formulate or discover archetypical narratives, or identify story types has been an endeavour common to folklore and narrative studies, as well as comparative mythology and anthropology, for many decades (Aarne, 1961; da Silva and Tehrani, 2016; Frye, 1951; Ip, 2011; Morden, 2016; Propp, 1958; Rowe, Ha and Lester, 2008; Tehrani and d'Huy, 2017; Uther, 2009). However, while this cross-cultural research can only contribute modestly to that overall goal, I have been able to investigate the nuances of narrative and how they are culturally influenced (Bohannan, 1966).

6.5.3 Suggested adaptations of the FPPT and its implications for social learning

This study demonstrates that this task can be successfully employed to explore questions at the heart of current endeavour in CE. There is potential to determine the relative success of different types of information, investigate different modes and scales of transmission, and carry out cross-cultural analysis of this data. Here, I have demonstrated different ways to adapt the FPPT and the data collected has

raised further questions. However, to test these questions empirically, the FPPT requires further adaptation. In exploring how story sequence varies with greater familiarity we see mixed results regarding stories becoming similar or clustering. Although results were non-significant, we see that stories become more similar with greater familiarity (Figure 6.5), however, the distribution of story sequences remains similar in phase three to phase one (Figure 6.6). This version of the task includes two confounds that may affect this result: 1) the mode of storytelling; and 2) the group size. Future experiments should control for these confounds by testing either individuals or dyads across all phases and using either written or oral modes. While all stories in phases two and three were complete, this was not the case for phase one. Future studies should increase the time limit for story creation to at least 30 minutes to ensure stories are complete across all phases. As participants do not have to use all the time, this can provide another measure of familiarity with stimulus material.

It is also conceivable for the FPPT to be used to study cultural transmission. This task could be further adapted to explicitly investigate the effect of multiple cultural parents by priming participants with other variants of the stories before they create their own. In a similar vein to Eriksson and Coultas' (2012) multiple cultural parent experiment, the FPPT could be operationalised to investigate choices between individual and social learning. Instead of having conditions where participants are exposed to variants of a story from multiple cultural parents, participants can familiarise themselves with the images before hearing the story told by another participant. After hearing the story, they in turn can tell their story to another participant, either transmitting the narrative they have learnt from another, creating their own based on the images or a combination of both.

A benefit of this elicitation task over more traditional transmission chain experiments is that there is potential to explore innovation and transformation rather than recall alone. By having images available throughout the task, which reduces the cognitive load, participants can refer back to the images as memory aids (Laeng et al., 2014; Lord, 1980; Tong, 2013). Furthermore, if images are present, it is more likely that any narrative passed on to another person is due to storyteller choice rather than story decay.

There is also some evidence presented in this chapter to suggest that there is an effect of hearing other variants of the stories (see Figure 6.4). We already see that participants create more content biased stories together if they were previously drawn to different cues. We might eliminate the 'preparation' phase in order to mimic spontaneous group storytelling. Furthermore, if we also include the presence of an audience who are blind to the task as the standard protocol suggests (San Roque et al., 2012), we can begin to test how effective the different strategies that participants use are.

However, there are many avenues that we have not explicitly addressed here and that can be avenues for future research. As this protocol has been created for the study of naturalistic speech, cultural evolutionists should be interested in this task design. Transmission is often verbal, or accompanied by verbal instruction, particularly when teaching is the mechanism for human social learning. We often focus on the content of the information itself (Bebbington et al., 2017; Heath, Bell and Sternberg, 2001; Mesoudi, Whiten and Dunbar, 2006; Stubbersfield and Tehrani, 2013) or information about those transmitting information (Atkisson, Mesoudi and O'Brien, 2012; Chudek et al., 2012; Harris and Corriveau, 2011), yet, this model-based information can come from multiple sources (see Chapters 4 and 5). By investigating naturalistic speech we can infer information about the motivations behind cultural transmission, and how aspects of discourse such as turn-taking might influence the opportunity for, and success of, transmission.

Additionally, the conversations between participants in the oral storytelling phase have been recorded. Here, we have a rich source of cultural and linguistic data that can be examined regarding the conscious strategies we use to negotiate and in our decision-making processes (see Chapter 7). Further research should use conversational analysis to determine how participants interact with each other and link this to material on accommodation (Buller and Aune, 1992; D'Arcy and Tagliamonte, 2010; Giles, Coupland and Coupland, 1991), prestige and dominance (Berl et al., forthcoming, see Appendix B; Brand and Mesoudi, 2019; Cheng et al., 2016; Henrich and Gil-White, 2001). In this way, this study can highlight the different cues we use to signal authority.

We can see that stories are a flexible way of conveying information but this needs to be tested in a variety of contexts. There are myriad ways in which we signal

important information and we need to be aware of these cues before we attribute influence to set biases (see Chapter 5). What is presented in this chapter is one application of the FPPT, but the variation it promotes allows for the study of different topics such as kinship, attitudes towards social norm violations and group dynamics. The FPPT not only elicits linguistic markers but a wealth of cultural information that demonstrate why storytelling is such a cross-culturally rich domain.

Chapter 7: Getting Your Voice Heard: A Novel Application of the *Family Problems Picture Task II*

7.1 Abstract

In the creation of collaborative stories, people have to negotiate the content, the narrative structure and the performance of a story. These negotiations can provide a fruitful source of data to study group dynamics. Here, I use the conversational data elicited from the second phase of the *Family Problems Picture Task* to investigate dyad dynamics regarding dominance. Previous research has established that there are several interactional cues, which can signal dominance. I test whether there are differences in the time participants spend speaking, and investigate if more dominant participants are more likely to engage with images, and leave shorter gaps between turns. I find that participants vary in their time spent speaking, however, I find no relationship between dominance and turn taking. This study provides a new way to investigate dominance particularly in the presence of unknown interlocutors, and demonstrates further potential applications of the Family Problems Picture Task to explore questions relevant to cultural evolution.

7.2 Introduction

The Family Problems Picture Task (FPPT) can be adapted to investigate other questions of interest to those who study cultural evolution (CE). In the previous chapter we focused on the output of the task: the narratives produced during each phase. However, this task elicits other information in the form of interaction between members of the dyads. In this chapter, I focus on the discussion output of the previous study and analyse the dynamics of the conversations held within dyads as they navigate through potential narratives and decide how to co-create a story. Here, I present the results of conversational analysis, particularly turn-taking and conversation dominance, and demonstrate how this task can be applied to investigate prestige and dominance.

7.2.1 Prestige and Dominance

Although prestige and dominance has been well studied in the CE literature, questions about the effect of prestige on CE remain unresolved with mixed results (Acerbi and Tehrani, 2018; Atkisson, Mesoudi and O'Brien, 2012; Brand and Mesoudi, 2019; Chudek et al., 2012; Garfield, Hubbard and Hagen, 2019; Henrich and Broesch, 2011; Jiménez and Mesoudi, 2019a; b; Jiménez, Stubbersfield and Tehrani, 2018; Little et al., 2015; McGuigan, 2013; Reyes-Garcia et al., 2008). It is likely that prestige has a varying effect across different domains. The most commonly used distinction between prestige and dominance in CE comes from Henrich and Gil-White (2001) who distinguish prestige and dominance on the basis of third parties. 'Prestige' is considered to be something bestowed on an individual by others based on some form of success. However, as it is the individual that carries prestige and not the behaviour, prestige is conferred all aspects of that individual's behaviour, regardless of success in that domain (Brand and Mesoudi, 2019). Prestige is often measured in deference on the part of others through submission or respect given and is therefore visible to others. On the other hand, an individual asserts 'dominance' over others usually through inciting fear or coercion; subordinates demonstrate submission usually to protect other resources (Cheng et al., 2013b; Maner and Case, 2016).

Compared to prestige bias, dominance is relatively understudied. Dominance studies tend to be in relation to prestige, tested through ranking scales (Brand and Mesoudi, 2019; Chambers and Hammonds, 2014; Cheng and Tracy, 2014; Cheng et al., 2013b; de Waal-Andrews, Gregg and Lammers, 2015; Redhead et al., 2019; von Rueden, Gurven and Kaplan, 2011). Beyond fear and coercion, there are other factors that contribute to whether a person is perceived as dominant. Previous CE research regarding dominance has demonstrated that modulating pitch effects social rank (Cheng et al., 2016). Cheng et al. (2016) investigated how vocal pitch is used to signal social rank and dominance. Irrespective of baseline pitch, altering one's pitch early in the conversation so as to be lower predicted higher social ranking. The deepening pitch profile was linked to dominance rather than prestige as pitch has been linked to perceived body size in both human and non-human animals (Charlton, Reby and McComb, 2007; Cheng et al., 2016; Fitch, 1997; Harris

et al., 2006; Puts et al., 2007). As the FPPT allows for the collection of audio data, we are able to use aspects of voice and conversation to investigate prestige and dominance. Here, the data collected refer to dominance dynamics.

The FPPT *could* be adapted to engineer prestige conditions by presenting manipulated information about one member of the dyad to the other, but there is a risk that a participant might reveal incongruent information. This issue could be avoided by introducing confederates who had to play a high or low prestige character. However, the use of confederates also has limitations as they have to engage as co-creators of the story and react in the same way across multiple interactions. Confederates would have to react in a consistent manner within conversations with participants without any repercussion on the narrative outcome. Alternatively, and in keeping with Henrich and Gil-White's definition of prestige (2001), one could manipulate perceptions of individual prestige by providing controlled information about how an artificial audience rated participant's initial individually created story. In this final case, prestige is directly linked to story creation and so may be interpreted as a success bias. With prestige, we expect the effect of success in an unrelated area to influence perceived success in other domains.

For the reasons discussed above, artificial manipulations of prestige can be problematic in interactional studies. As this understanding of prestige depends on input from third parties, this is not directly relevant to *this* adaptation of the FPPT. However, I have demonstrated in previous chapters that people are able to distinguish relative prestige of others without third party influence (although usually based through on previous personal experience) through accent. As the FPPT is an elicitation task, there is opportunity to generate different styles of speech including storytelling performance and informal conversation. Participants could be recruited with different accents to manipulate prestige either through evaluating how much of each individual's phase one stories are retained in successive phases, or through investigating how people's behaviour changes through accommodation.

7.2.2 Prestige and Accommodation

Although I do not focus on this here, the FPPT task could be used to study prestige in the form of accommodation. Accommodation is how an individual changes their behaviour to adapt to their interlocutor (Dragojevic, Gasiorek and Giles, 2015; Giles, Coupland and Coupland, 1991; Muir et al., 2016). This may be through linguistic changes, such as adapting the accent or changing their speech patterns (D'Arcy and Tagliamonte, 2010), or interactional, such as how they orient themselves in relation to other individuals or direct gaze (D'Agostino and Bylund, 2011). Accommodation is directional: people adapt their behaviour to ease understanding or communication (converge) (Buller and Aune, 1992) or to disassociate themselves from others (diverge) by exaggerating differences or exerting dominance (Giles and Gasiorek, 2014).

The FPPT task lends itself to the study of accommodation as it allows the opportunity for extended conversation as part of the second phase. In this phase participants have 15 minutes to rearrange the images and co-create this story. As this is a collaborative task, they can spend this time discussing how to complete and present the story. Dyads have to negotiate the content of this story opting to either combine elements of their previously individually created story or co-create anew. As these discussions are audio- and video- recorded, we are able to capture these conversations and analyse how participants enter negotiations and talk to each other. As the participants are able to set up the images in any configuration of their choosing, I use the video recording to analyse how participants use the space.

I do not address accommodation in the results of this chapter as I recruited participants who self-declared a proficient level of English but did not collect data or manipulate the dyads on the basis of accent. This task could easily be adapted to do so and investigate the patterns of accommodation between differently accented members of the dyad. As has been established in Chapter 4, accents demonstrate variable prestige and perceptions of accent prestige are relatively stable (Bishop, Coupland and Garrett, 2005). One might theorise that: a) speakers may adapt their speech over time to use variants more in line with the other speaker (convergent accommodation), or b) speakers may over-exaggerate variants in line with their own accent to disassociate with the other speaker (divergent accommodation)

(Giles, Coupland and Coupland, 1991). As participants share a common goal to co-create this story, it is intuitive that speakers' speech and behaviour should be in line with what would be expected of convergent accommodation and there is no direct reward for dominating this interaction. However, as this task has been adapted so that participants have already familiarised themselves with the images in the first phase of the task and already created their version of events, we may find conflict in how participants attempt to reconcile different stories elicited from the same stimulus material. This conflict between previously held versions of events and newly created versions of events may lead to dissociative behaviours between members of the dyad associated with divergent accommodation as each member strives to ensure that their voice is heard (Heck, 2016; Matiss, 2005). This conflict may be exaggerated in cases where there is an obvious imbalance of power or prestige (Druin, 1999).

7.2.3 Conversation Dynamics

Within a conversation there are many forms of interaction. Conversation analysis is a qualitative method of analysis which seeks to understand and characterise the maintenance of social order in interaction through conversation (Bloor and Wood, 2006; Seedhouse, 2005; Westerman, 2011).

Within speech itself, there are many ways to signal authority. Authority may be signalled through prestige based on accent and accommodation (Milroy and Milroy, 1999). Authority could also be signalled through dominance (Cheng and Tracy, 2014; Cheng et al., 2013b), based on pitch (frequency) or loudness (amplitude) of the voice (Borkowska and Pawlowski, 2011; Puts, Gaulin and Verdolini, 2006; Tigue et al., 2012; Tusing and Dillard, 2000). Even the language we use can signal authority. Political speeches are often studied to demonstrate authoritative cues (Charteris-Black, 2018; Feng and Liuu, 2010; Rose, 2000).

There are also non-verbal ways to interact that can also signal dominance. Previous research has suggested that dominant parties are more likely to talk more and move the most, signalling to other members of the group that they are dominant (Aran and Gatica-Perez, 2010; Jayagopi et al., 2009; Mast, 2002). Turn-taking is a well established measure in conversational analysis that examines the structure of

interaction in a conversation (Beňuš, Gravano and Hirschberg, 2011; Kendrick, 2015; Levinson, 2016; Sacks, Schegloff and Jefferson, 1978; Schegloff, 2000; Stivers et al., 2009). Turn-taking organises conversations by having each interlocutor speak in alternating turns. It is expected that, at a given time, one person is speaking and each turn receives a response (Holler et al., 2015).

Research has found that, although there is variance in the time taken between turns across different languages, people avoid overlapping speech (Stivers et al., 2009). However, turn-taking is imprecise and often there are overlaps in speech (Heldner and Edlund, 2010). Heldner and Edlund categorises silences into two types: pauses and lapses, which are determined by the speaker on either side of the silence. People have to evaluate whether interlocutors are pausing in their speech or whether the turn has ended, and errors in this judgement can lead to overlapping speech. Other research has found that interruptions or overlaps in speech are also perceived as signals of dominance (Dunbar and Burgoon, 2005; Youngquist, 2009). The conversational data elicited from the second phase of the FPPT is ripe for analysis of turn-taking and dominance.

7.2.4. Negotiation

By co-creating a story as part of phase two of the FPPT, participants enter into negotiations about how they are going to order the images, how they are going construct the story, the content of the story as well as how they are going to perform the story. Participants may even undergo 'negotiation of meaning' through seeking clarification and confirmation (Nakahama, Tyler and van Lier, 2001; Oliver, 2002; Shekary and Tahririan, 2006) to understand their interlocutor's reasoning behind decision-making processes. The success of a negotiation depends on how conversation is managed (Glenn and Susskind, 2010). Negotiation interactions draw upon a multitude of tools that allow for successful communication, including embodiment (e.g. through gesture, posture and eye gaze) and modes of communication. For example, it has been well established that the use of open-ended questions (compared to close-ended questions) removes biased responses and generates extended, more detailed responses from interlocutors (Geer, 1988, 1991; Heritage and Robinson, 2006; Nelson-Gray et al., 1989; Reja et al., 2003).

Participants have to navigate how to complete all aspects of this task successfully with the time frame given. One might expect one individual to take the lead to ensure that conversation moves on to relevant topics to ensure all aspect are covered (Stokoe, 2000). In Stokoe's (2000) study of small group discussions between university students during seminars, she noted that students would often open conversations by clarifying the task(s), orienting members of the group to the expected structure of the conversation. She also finds that separate topics are clearly demarcated by long pauses at the end, followed by topic transition markers like 'right' or 'so' (Stokoe, 2000). We would expect to find similar markers in FPPT conversations as participants are presented with tasks and will have to negotiate topics of discussion to achieve their aims. We might expect that individuals who are more likely to take the lead in structuring the conversation and introducing new topics are considered more dominant (Mazur and Cataldo, 1989).

In this chapter I will analyse dyadic conversations regarding the development of the co-created stories in the second phase of the FPPT. As there is a time limit to complete this task, we might find a dominance imbalance to ensure the task is completed. However, there is evidence to suggest that, under stress, group leaders become more receptive to information from other and authority remains non-centralised (Driskell and Salas, 1991). As this is a collaborative task without incentivisation, I expect that interlocutors will submit to each other, without one participant being dominant over another.

For the purpose of this task we attribute dominance to the participant who speaks most overall in each dyad. Here, I aim to investigate: a) whether there is a difference in amount of time spent talking within dyads; b) whether there is an imbalance in time elapsed for turn-taking between interlocutors; and c) whether speakers who spend more time talking also spend more time in contact with the images to create the order.

7.3 Methods and Materials

7.3.1 Participant instructions

Participants were briefed about what was expected from the second phase as the overhead and main (visible) cameras were tested. Participants were seated at a large table with laminated copies of the images they had already seen in the first phase in reach of them. The images were stacked face down in a pile in presentation order (see Table 6.1) with the first image on top and the last image at the bottom of the pile. I instructed participants that they had 15 minutes to order the images and create a story based on the images together. I informed the participants that the camera would be recording throughout and I would be outside the room if they required anything. They were notified that they did not have to use all 15 minutes of their allotted time and, should they complete this part of the task early, they could summon me back to move onto the second part of the phase. Participants were told that when I re-entered the room, they were expected to tell me their story. I told the participants that it was up to them how they wished to present the story and their 15 minutes of deliberation began as soon as I left the room.

7.3.2 Data Analysis

Approximately 3 hours and 4 minutes of recording were collected pertaining to these conversations. I have excluded data from two dyads, due to technical issues with the recordings. A third dyad was excluded from this analysis as one of the participants brought along their infant. The recording included child-directed speech which skews the analysis of these data. Five of the 13 dyads included in this study used all the allotted time to co-create their story. Of the eight dyads who summoned me before their time elapsed, conversations lasted between 3 minutes and 49 seconds and 11 minutes and 32 seconds (mean: 10 minutes and 44 seconds, SD: 4 minutes and 1 second). I took four measures of dominance as part of this conversation analysis: 1) the time spent speaking for each interlocutor; 2) the time elapsed between turns; 3) overlaps and interruptions in speech; and 4) engagement with the images for each individual. Conversational analysis was carried out using

ELAN 5.7 software. I used the segmentation tool to collect the data and calculated durations of speech, overlaps and gaps. I used the R statistical environment to carry out any statistical analysis. I present data from the first third of each conversation as previous research has determined that dominance is established early on (Cheng et al., 2016; Curhan and Pentland, 2007). As conversations varied in length between dyads, any measurement of time has been turned into a ratio. I have assigned participants as 'dominant' based on greater time speaking within a dyad (Hall and Friedman, 1999; Mast, 2001, 2002). In the measurement of turns, I have excluded any gaps that are lapses within a single participant's speech (Heldner and Edlund, 2010). I measured engagement with the images by the number of times a participant came into contact with, picked up, moved or gestured towards an image. Image interaction has also been calculated to represent number of interactions per second for comparison purposes and can be used as a proxy for commanding the physical space.

7.4 Results and Discussion

After standardising measurements for comparison across recordings, I compared means for time spent talking, average length of time between turns, average length of time of interruptions and the number of interaction with images per second between dominant and non-dominant participants. All data was non-normal with the exception of time spent talking therefore, I report results for Welch's t-test for time spent talking and Wilcoxon t-test for all other variables. I found a significant difference between the dominant and non-dominant groups for time spent talking ($t(21.943) = -6.0126$, $p < 0.001$). However, I found no significant results for differences in average length of time between turns ($W = 88$, $p = 0.880$), average length of time of interruptions (overlaps) ($W = 100$, $p = 0.448$), and interaction between images between groups ($W = 50$, $p = 0.081$). Figure 7.1 shows the differences between dominant and non-dominant participants across all tested variables. These results suggest that there is no difference between time between turns, overlaps and the amount of interaction, irrespective of dominance.

Although I control for gender effects within the dyads, I also compared the effect of gender on the tested variables. I found no significant differences for: time spent talking ($t(22.031) = 0.218$, $p = 0.830$); average length of time between turns ($W = 57$, $p = 0.241$); average length of time of interruptions (overlaps) ($W = 83$, $p = 0.897$); and interaction between images between groups ($W = 55$, $p = 0.201$). Although previous research (Mast 2001) has shown gendered differences between men and women where all-men groups were initially more hierarchically structured based on dominance variables than all-women groups initially, we do not find evidence to support this prediction here.

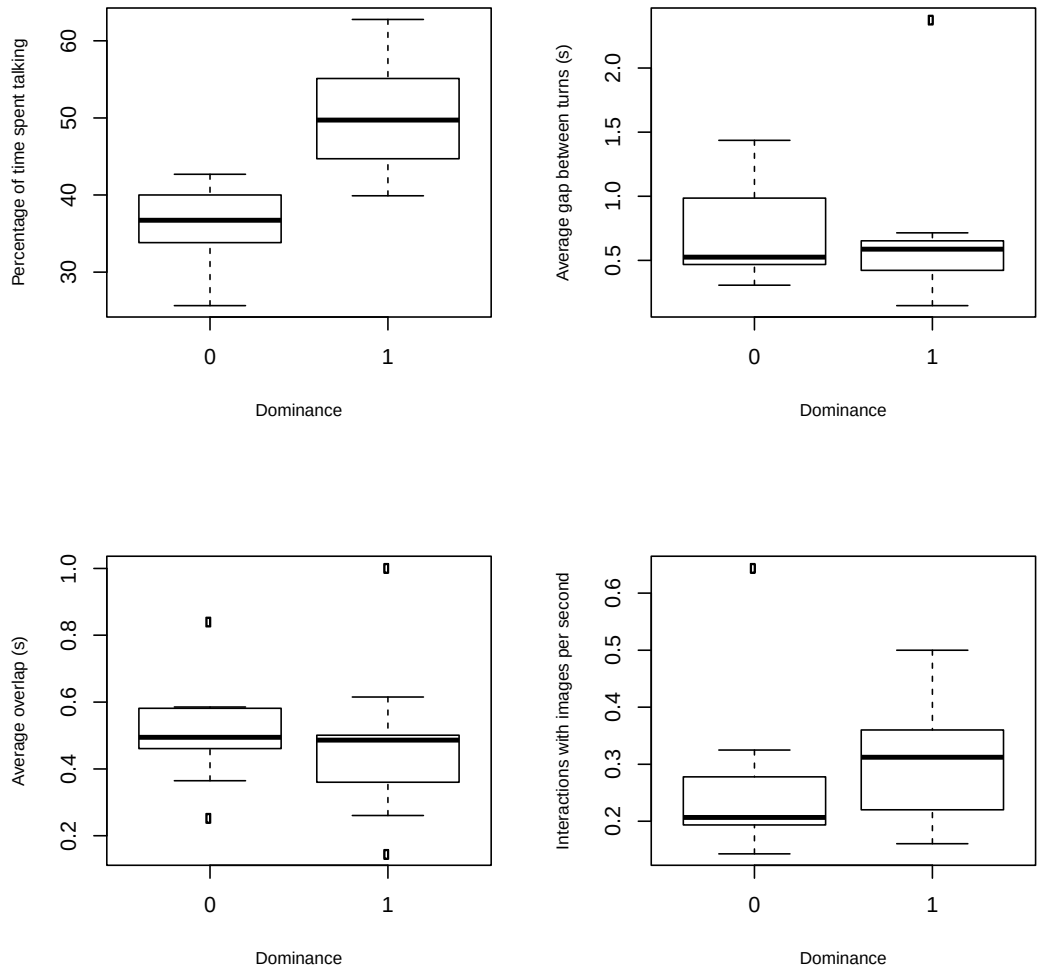


Figure 7.1. Plots demonstrating the differences between interlocutors. Participants are depicted across the x-axis with interlocutors that spoke more in the conversation allocated as dominant (1). From the top left clockwise, the graph shows: the difference in time spent talking standardised across conversations; the difference in average gap between conversation turns; the difference between participant's interactions with the images; and the difference between average lengths of interruptions (or overlapping speech).

Due to non-normal data I ran Spearman rank correlations between all variables and found a significant positive correlation between time spent talking and interactions with images (Rs = 0.393, $p<0.05$). Figure 7.2 shows the correlations between all the variables. I found slight negative correlations between: time spent talking and average time between turns or overlaps; number of interactions with images per second and average time between turns or overlaps; and a slight positive correlation between average time between turns and overlaps. However, none of these correlations were significant (Figure 7.2). These data support the prediction that participants who spend more time speaking are also more likely to interact with the images.

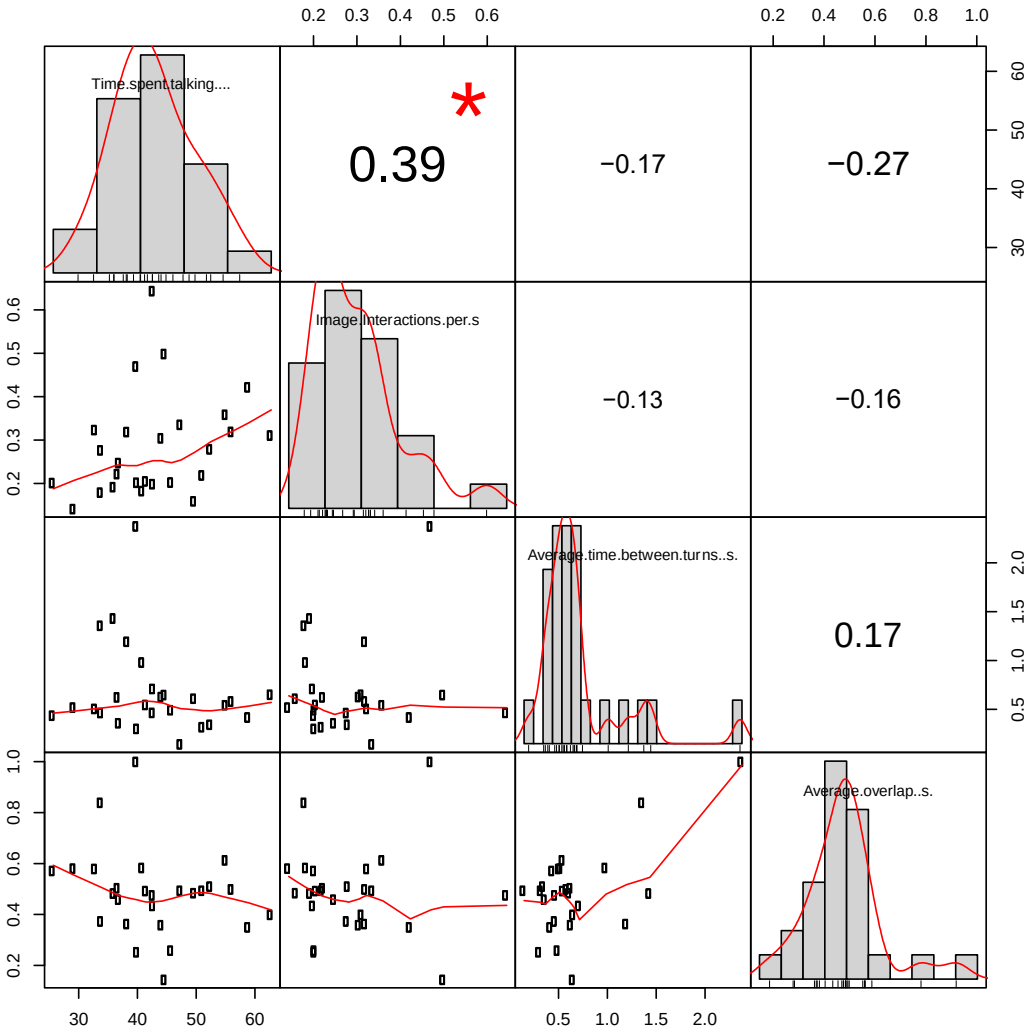


Figure 7.2. Plot showing correlations between conversational variables. The diagonal from top left to bottom right shows the distribution of the variables studied. Plots below this diagonal show scatterplots with fitted lines of Spearman rank correlations between each variable. Correlation coefficients are shown above the diagonal with significance denoted by stars.

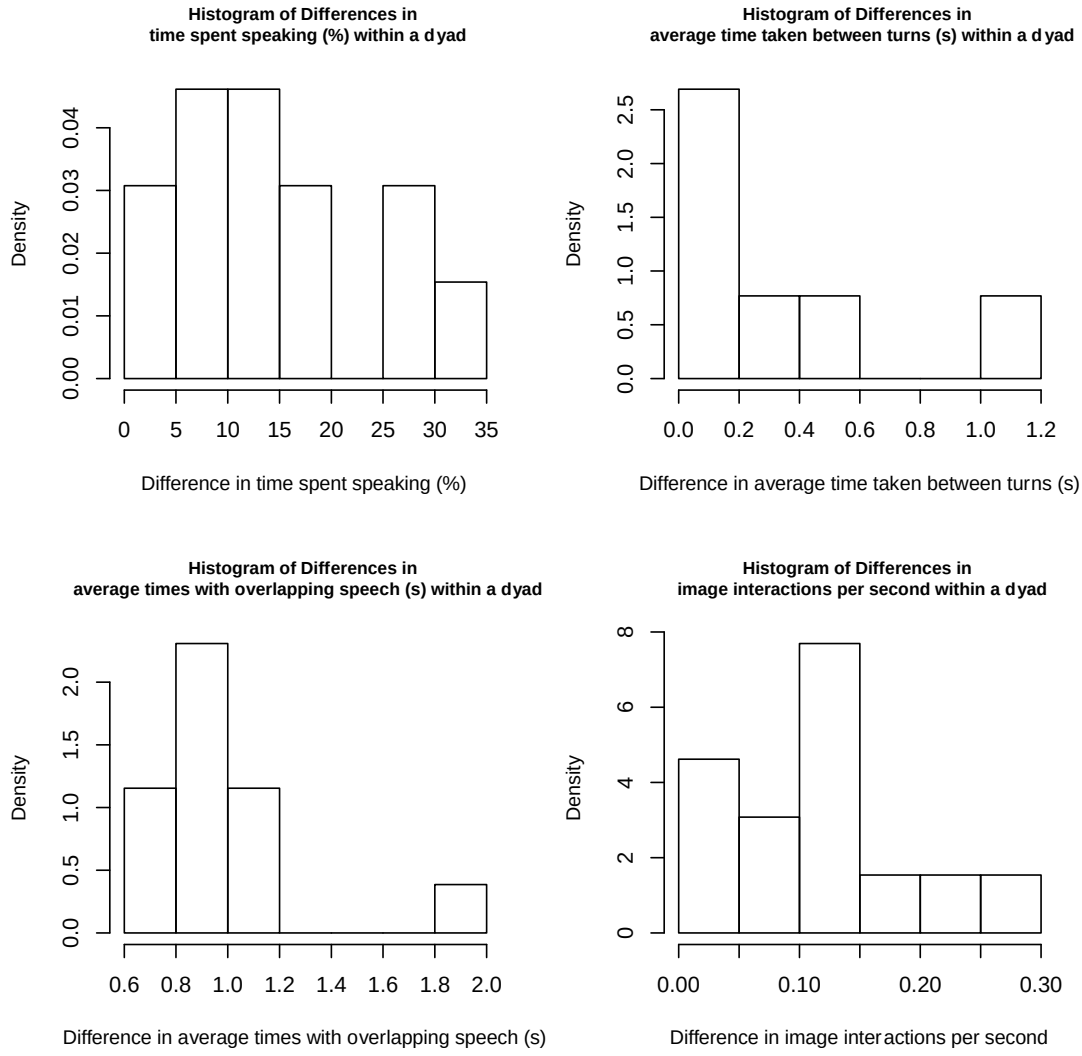


Figure 7.3. Frequency distribution of differences in tested variables within dyads. These histograms show the differences in participant response based on, from top left clockwise: time spent speaking, average turn length, interaction with images per second and interruption length. The measurements are taken irrespective of which interlocutor in each dyad is ascribed dominance.

I expected that, if we were to see a dominance effect, we should see differences between dominant and non-dominant participants for all variables tested (Aran and Gatica-Perez, 2010; Beňuš, Gravano and Hirschberg, 2011; Jayagopi et al., 2009; Hung et al., 2011; Mast, 2002; Youngquist, 2009), however, we only see a significant difference for percentage of time spent talking (Figure 7.1). I also expected that participants who are more likely to interrupt speech to be more dominant (Youngquist, 2009), and for participants who are not dominant to have longer turn times to minimise potential for interruption. However, these data do not support these predictions. These results might be due to the fact that I ascribed dominance

on the basis of time speaking, taking the person who spoke most in each pair as dominant in line with other studies (Hall and Friedman, 1999; Hung et al., 2011; Mast, 2001, 2002). Had I operationalised dominance in another way, using a different cue such as interruption, shorter turn times and engagement with the images, we may find significant differences between groups for these variables. However, across dyads, participants also varied in the difference between time spent talking and all other tested variables (see Figure 7.3 and Appendix N). In Figure 7.3, we can see across all variables, differences are skewed towards the lower end of the scales, suggesting that, if there were a dominance effect for other tested variables, these would be small. This supports my initial prediction that, as this is a non-incentivised collaborative task, participants submit to each other acting as equals.

As all variables tested have been suggested as cues of dominance (with longer turn times a cue of non-dominance), I would expect measurements of these variables to correlate. I would expect positive correlations between time spent speaking, interruption length, and interaction with images, and negative correlations between average turn length between all other variables. We do see the expected significant positive correlation between time spent talking and image interactions per second, which suggests that speakers are more likely to take the floor both verbally and physically (Figure 7.2). We also find that average turn time correlates with these variables as expected, although very slightly and non-significantly.

What is surprising is that all correlations with interruptions, although non-significant and relatively small, are in the opposite direction to what is expected, which might suggest that interruptions are not a cue of dominance. This goes against previous literature suggesting that interruptions are a dominance behaviour (Karakowsky, McBey and Miller, 2004; Youngquist, 2009), however, this might be due to how interruptions are measured. To standardise across conversations, I have given the average interruption length. However, the interrupter alone does not necessarily control interruption length. If the interlocutor recognises an interruption and submits by stopping speaking earlier, the interruption length will be shorter but not through any behaviour on the part of the interrupter. Perhaps a better measure would be the number of interruptions (standardised per second) to

capture interruption caused by dominance. An alternative theory is that we see negative correlations with overlaps and other dominant behaviour because dominant participants are in such control of the conversation that non-dominant participants have to use dominant strategies such as interruptions to be heard. This breach of politeness is a 'face-threatening-act' and is used only when unavoidable (Morand, 2000).

I do not find any evidence to support an imbalance in time elapsed for turn-taking between interlocutors, which also goes against previous literature (Beňuš, Gravano and Hirschberg, 2011; Grueneisen and Tomasello, 2017; Itakura, 2001; Jayagopi et al., 2009). Again, how I have measured turn time may affect these results. I have measured a turn by a distinct separation of speech between interlocutors. However, one could argue that turns (or gaps) and overlaps are two sides of the same coin; both involve a switch in speaker even if there is not a transition between interlocutors. We could operationalise turns by subtracting overlaps from gaps, although the same caveats as applied to interruptions are still relevant. In this case, it might also be better to study the raw numbers of turns and interruptions standardised per second. Stivers et al. (2009) find that English speakers have a mean turn time of 236.07ms, although it unclear whether English refers to speakers of British English or another English. I find average turn (gap) time of 684.4 ms, which suggests that participants are, perhaps, deferring to others and taking longer to have their turn. However, this may be because I do not take overlaps into consideration. If I subtracted overlaps from turns (gaps), I found the average turn length to be 197.9ms, within the expected turn range for English speakers (Stivers et al., 2009). Another measurement that might have been interesting to study is the time elapsed between a single participant's speech events. This would provide a broader measurement that included not only gaps between interlocutor but also for how long an individual will tolerate an interlocutor speaking.

Unfortunately this analysis does not explore the types of interruptions that are included in these data. We find many examples of interruptions contained in interlocutor's speech that are simply utterances of agreement like 'mmhmm' and 'yeah' rather than true turns furthering the conversation (Stokoe, 2000; Ward and Tsukahara, 2000). Research has shown that silences are deemed to be awkward and we may find that these interruptions are expressed as a sign of engagement due to

social obligations in avoiding extended silences for each individual (Ohshima et al., 2015). Had these examples of backchanneling been excluded, we may see a different dominance profile based on interruptions and turns.

7.5 Conclusion

In this chapter, we have shown that the conversational data elicited by the FPPT is abundant in data for understanding group dynamics. Here, I have only studied conversational dominance in time spent talking, turn taking and interaction with images. It might be beneficial to provide participants with dominance (or prestige) scale questionnaires (Berl et al., 2019; Cheng, Tracy and Henrich, 2010) post interactions in to validate any perceptions of dominance, and to use as an unbiased measurement of dominance in the analysis. Only by using an external perception-based measurement of dominance can we validate the variables measured here as cues of dominance.

However, the task could also be adapted to study prestige, using accent as a cue for prestige, by recruiting and assigning participants with accents with differing perceived prestige to dyads. In this case, we can test how proportions of accent variants change over the course of the conversation to investigate how participants accommodate to one another (D'Arcy and Tagliamonte, 2010; Dragojevic, Gasiorek and Giles, 2015; Giles, Coupland and Coupland, 1991; Muir et al., 2016). We could also look at effects of speech rate and how this changes to accommodate to interlocutors by taking slices of data across the whole conversation (Buller and Aune, 1992).

These conversations are also rich in qualitative data, which could be used to understand group dynamics. Although not discussed here, we can establish dominance by understanding who shapes and drives the conversation forward, and who puts forward topics so that the task is achieved (Mazur and Cataldo, 1989; Stokoe, 2000). We could also test the hypothesis that in times of stress, leaders (or dominant participants) are more likely to gather information and listen to other interlocutors (Driskell and Salas, 1991).

Here, we are limited by the need to transform data so it is comparable between dyads. In future iterations of the FPPT, I recommend that researchers do not allow participants to end their conversations early and instead use all allotted time irrespective if they have completed the task. Not only will this allow researchers to operationalise raw data, such as the number of interruptions rather than the average length of interruption, but we would also be able to investigate how participants are likely to use this extra time. We would be able to elicit more data on how conversations stay on topic (or do not), and whether increased time given allows for more creative stories and performances. Chapters 6 and 7 have demonstrated that the FPPT is rich in data and flexible enough that it can be adapted to investigate group dynamics and understudied innovation in iterations of cultural material. This task provides a potential experimental paradigm to study cultural transmission and the early CE of storytelling, and I recommend that it be considered alongside other established methods of CE enquiry.

Chapter 8: Conclusions

In this thesis I aimed to strengthen bridges between linguistics and anthropology by demonstrating how sociolinguistic methods and theory can be fruitfully applied to study cultural evolution (CE). I have used the domain of storytelling to highlight some of the unanswered questions in cultural transmission (CT). Storytelling is already a popular method for studying CT (Bebbington et al., 2017; Eriksson and Coultas, 2012; Gottschall et al., 2004; Heath, Bell and Sternberg, 2001; Norenzayan et al., 2006; Smith et al., 2017; Stubbersfield, Tehrani and Flynn, 2015; Tehrani, 2013); however, linguistic and narrative factors themselves have been broadly ignored. Here, I draw together some of the overarching themes that emerge over the course of this thesis.

8.1 Cultural transmission

In this thesis I presented multiple experiments that address aspects of CT. I investigated how the presence of transmission biases influences what information is passed on in single-generation events. The transmission bias framework has been widely used to study the adoption of many behaviours (Acerbi and Bentley, 2014; Atkisson, Mesoudi and O'Brien, 2012; Baldini, 2012; Chudek et al., 2012; Eriksson, Cownden and Strimling, 2017; Haselton and Nettle, 2006; Jiménez and Mesoudi, 2019b; Kendal, Giraldeau and Laland, 2009; McElreath et al., 2008; McGuigan, 2012; Mesoudi, 2011; Reyes-Garcia et al., 2008; Takahasi, 1998; Wood, Kendal and Flynn, 2012, 2013). Rarely has the simultaneous effect of multiple biases been tested experimentally.

The centrepiece of this thesis was the transmission study (Chapter 5). Here, we attempted to quantify the effect of both content and context biases and found that multiple biases influence recall concurrently. Prestige has a relatively small effect, which is surprising considering its prevalence in the CE literature (Atkisson, Mesoudi and O'Brien, 2012; Brand and Mesoudi, 2019; Cheng and Tracy, 2014; Chudek et al., 2012; Henrich and Gil-White, 2001; Horner et al., 2010; Jiménez and

Mesoudi, 2019b; Zakharenko, 2012). In our study prestige was only cued by accent, an implicit form that relies on participants recognising inherent characteristics. The relatively small effect of prestige that we found may suggest that individuals rely on external support in establishing prestige (e.g. attentional cues and deference), as the other studies suggest, in addition to recognising inherent cues.

The smaller prestige effect is also unexpected considering prestige and other model-based biases lend support to the premise that high-fidelity transmission is key in CE (Chudek, Baron and Birch, 2016; Horner et al., 2006; Lewis and Laland, 2012; McGuigan, 2012). Unlike content biases, where information may be more efficiently transmitted not only through high-fidelity routes but recreated through attraction (Sperber, 1996; Buskell, 2017), information that is more likely to be recalled due to model-based biases needs to be recalled faithfully to survive. Considering that one of the unique tenets of human CE is cumulative cultural evolution (CCE) (Dean et al., 2014), we require transmitted information to be sustained, not lost to ensure the ratchet effect continues (Tennie, Call and Tomasello, 2009). However, our results suggest that high-fidelity transmission is not always present. Jiménez and Mesoudi (2019a) find a similar effect where prestige does not influence transmission fidelity of controversial arguments. The findings from these recent studies do not support that prestige affects fidelity and, therefore, the original model-based assertions about prestige (Boyd and Richerson, 1985; Henrich, 2004b) should be reassessed using experimental and observational methods.

Content biases seem to have a greater effect than prestige on recall. We would expect content-biased information transmission to require some degree of fidelity, yet these biases only explain some of the variation. Although content-biased information appeals to relevance and/or memorability, to what extent we can use recall as a reliable measure of CT is unresolved. This issue was not considered as part of the transmission study or the Family Problems Picture Task (FPPT). Whereas the transmission study (Chapter 5) purely investigated recall, memory was not required in the same way in the FPPT as images were present throughout (Chapter 6).

Using the FPPT, I examined how stories are transformed over successive generations, exploring whether opportunities for innovation were realised.

Innovation itself is difficult to reliably test. How much can we ascertain to be truly novel within an experimental context? Could an 'innovation' be based on any recalled form of other prior knowledge (Reader, 2003)? The findings of the FPPT can be interpreted through both a content bias lens and by cultural attractor theory and, therefore, we cannot determine whether this information has been successfully recalled, or whether our participants are recreating these representations independently.

The transmission study (Chapter 5) shows that relatively little variance can be explained by transmission biases alone (see section 5.3.2.3). Therefore, there are likely to be other factors that contribute to variance that were not accounted for in our variables. Yet this study accounts for more independent variables (including prestige, several content biases, memory, demographic factors) than most CT experiments, suggesting that it is premature to draw causal inferences solely based on the presence of one type of biased material. One can only determine the relative importance of biases based on a critical mass of comparative, replicable studies. Has the influence of transmission biases been overestimated in CE? Transmission biases do provide a useful framework for studying transmission, however, it is imperative to ground each experiment in its domain-specific context (e.g. storytelling). To this end, future research should consider other disciplines related to the medium of transmission to achieve this goal.

The next two sections focus on the other fields drawn upon in this research and here I evaluate the ways that broadening the remit of CE explanation, by considering language and narrative performance, have added to understanding CT.

8.2 Linguistic factors

While language is generally acknowledged to be a paradigm case of a culturally evolving system (Gray, Greenhill and Ross, 2007; Kirby, Dowman and Griffiths, 2007; Kirby, Griffiths and Smith, 2014; Kirby, Cornish and Smith, 2008; Smith, 2011; Smith and Kirby, 2008), this research demonstrates why the role of language as a mechanism should be taken more seriously. In Chapter 3, I proposed that linguistic variables are subject to Darwinian processes and that this can explain why certain

variants reach stability over others, a paradigm that has been well established (Croft, 2000, 2008; Fay, Garrod and Roberts, 2008; Pagel, 2009, 2016, 2017; Ritt, 2004; Tamariz and Kirby, 2016). Furthermore, many of the social categories indexed by speech correspond to model-based biases. When framed this way, we can use a range of linguistic data for CT experiments. I employed turn-taking and conversational dominance to operationalise dominance using the FPPT task (Chapter 7) and this task could be further manipulated to study prestige effects. People gather information from multiple sources: voice can be a useful signal of information indexing broad social categories. By using voice, and particularly accent, as a signal of contextual information, this opens new avenues to apply transmission bias frameworks to data transmitted through different media. Voice is a particularly important source of information to be considered because we verbally transmit both propositional content and socially indexed information. Any form of oral transmission will have voice as an additional source of information about the transmitter, and this should be addressed or controlled for in CT experiments.

We can also use features of voice to manipulate transmission biases. As demonstrated in Chapter 5, we can exploit accent, one feature of voice, as a source for these model-based biases. Accent is a particularly useful source of information because we are able to draw upon this contextual information in the absence of other knowledge requiring surveying the population, such as success or frequency. Only one study, to my knowledge, has been carried out using voice (Cheng et al., 2016) to establish prestige in human CT, yet voice has been frequently studied in regards to prestige and dominance (Cheng and Tracy, 2014; Hodges-Simeon, Gaulin and Puts, 2010; Kalkhoff, Thye and Gregory, 2017; Puts et al., 2007). In my work, accent proved to be a reliable cue of prestige with participants confirming both that accent indexes prestige and the relative prestige of the different accents used in this experiment.

However, accent itself may be an additional confound in transmission studies. In the language attitudes survey (Chapter 4), we demonstrate how accent can index information that can be used to manipulate model-based biases. Accent indexes multiple forms of social information, and we are unable to tell from our data in the transmission study whether participants are using accent to access prestige information or any other form of social information. We attempted to control for this

by having speakers who had similar age, gender and education characteristics; however, we could not control for perceived familiarity or friendliness, which also may have affected transmission.

I also investigated the impact of language attitudes and whether this, in turn, signalled to our participants to create more emotional stories (Chapter 5, study 2). Considering that negative emotional content was highly recalled (Chapter 5, study 1), it was unexpected that participants' recalled stories did not become more emotional. In recall-based transmission studies, only one part of transmission is observed; however, this does not account for what is expressed. This method facilitates investigation of transformation and new content in recalled stories, providing a more nuanced view of the transmission process.

Together these studies demonstrate that sociolinguistic methods, explicitly used in Chapters 4, 6 and 7, can be fruitfully applied to questions about CE and can inform CT experiments (Chapter 5).

8.3 Narratives

The results from our transmission study suggest that there are other non-bias factors (e.g. narrative structure, agency) that influence the retention of information. Although we were aware that narrative devices (e.g. repetition of a set phrase) might affect successful recall, these kinds of devices are particularly difficult to quantify. To control for some of these narrative devices we ensured that the 'reading level' of the vocabulary and sentence structures were consistent between stories; however, this confound is not fully captured in our measurements and is often not considered in transmission studies using narratives (Eriksson and Coultas, 2012; Heath, Bell and Sternberg, 2001; Mesoudi, Whiten and Dunbar, 2006; Stubbersfield, Tehrani and Flynn, 2015). To understand why stories can be used to transmit information we have to understand how individuals create stories and the active decision-making processes behind this.

In stories elicited by the FPPT, we find that rationalising information is not always found in the story content itself but in the commentary. Indeed, we also find in the transmission study that participants provided metacommentary on the

stories. For example, some participants recognised that the narratives transmitted were creation stories, some commented on the parenting style of 'Mata' and 'Pata' in *Muki* (see Appendix D for stories). Being able to provide commentary is a particularly useful prop in oral transmission because not only does it allow for signalling but also repair (Hayashi, Raymond and Sidnell, 2013) when narratives or speech are unclear. In studies investigating CT through narratives (Barrett and Nyhof, 2001; Bartlett, 1920; Bebbington et al., 2017; Mesoudi, Whiten and Dunbar, 2006; Stubbersfield, Tehrani and Flynn, 2015), the focus is only on the stories themselves but, in reality, individuals use many other techniques that can scaffold our learning. As such, storytelling may be an even richer vector for transmission information than what we capture in current CT experiments, particularly if accompanied by material props.

The role of memory in narratives also requires further study. We accounted for working memory in the transmission experiment and removed memory as a factor in the FPPT by having the images present throughout. Having the images available for reference allowed participants to review all events included and to edit the sequence without losing continuity. Had the images not been there after the first phase, I would expect that events would have been omitted, consistent with the loss of information we found in Chapter 5, and that the stories created would be more disjointed and require further explanation to create a clear narrative. We can observe differences in storytelling capability based on prompts. All participants were able to create a coherent narrative in the FPPT as they had visual cues in front of them throughout. By contrast, many of the participants in the recall-based transmission study struggled to create coherent narratives (see Appendix F, Taka and Toro USA_1503126188250 Low Prestige for an example) and commented on the limits of their memory. However, these experiments could be modified to test how memory capabilities can constrain both the storyteller and the audience (Horton and Gerrig, 2005). It is particularly unclear how storytellers recognise the memory capacity of their audience and adapt their narratives to meet these needs in experimental environments where they may not know their audience and might not even interact with their audience directly.

When participants repeatedly tell stories, it is unclear whether narratives decay due to memory constraints or whether storytellers are actively selecting

information. One participant in the transmission study helpfully recalled moral information but also provided an alternative: “And the bird heard and he flew down and ate the crab because the crab deserved to be eaten because he was lazy and the *lazy don't prosper* in this world, or he could've just been hungry but we'll go with the lazy don't prosper…” (USA_1502323811485, 2017). Here, we see that the original information (italicised) is retained but the participant had an alternative theory (underlined) and did not have to transmit this information. Despite this, we see in Chapter 6 that the flexibility of narrative form and structure make stories effective and, even within a small sample and given the same contexts, the data demonstrate great variation. Storytelling is adapted to suit the purpose of the storyteller and the needs of the audience, even if the mechanisms are still uncertain, making it an efficient communication form.

The transmission study and the FPPT are just two ways in which narratives can be applied to study CT. By drawing upon narrative theory we may be able to explain more of the noise in transmission (for example, whether signalling importance through commentary results in attention loss for non-signalled information) and determine the specific effects of social transmission biases on successful retention and expression of information.

8.4 Outstanding questions and future directions

Although we have successfully demonstrated that sociolinguistic methods can be applied to cultural evolution studies there are still some debates that have not been addressed here and inevitably further questions which have arisen from this research.

There has been recent movement to go beyond the WEIRD and avoid presenting results as panhuman with no basis (Henrich, Heine and Norenzayan, 2010a; b). Although the empirical research in this thesis has been carried out with UK and USA-based participants, however, the FPPT was designed for cross-cultural research (San Roque et al., 2012), and we designed the transmission study to maximise cross-cultural utility. Throughout this thesis we have emphasised the importance of locally calibrating experiments and devising culturally appropriate

methodology. Our language attitude study (Chapter 4) demonstrated how meaningful relevant accents could be, which we then used in turn to calibrate our transmission experiment (Chapter 5).

In particular, the creation story transmission experiment can be adapted to be relevant to different populations because the creation stories were built by surveying cross-cultural data and they were designed to be ethnically non-specific. The mode of oral transmission does not presuppose literacy, and accent prestige can be calibrated for different locations (e.g. The Netherlands (Grondelaers, van Hout and Steegs, 2010); Taiwan (Lee, 2004)). As our results have shown, there is variation in how we are influenced by social transmission biases at the individual level, but this too may also be culturally constrained. This task may deliver different results when carried out with non-WEIRD populations as creation stories may have a greater association with prestige than what was found with WEIRD populations. Creation stories are often associated with religion or spirituality; however, in many Western countries there is some level of separation of religion and state. Although religion is still afforded prestige (Collins, 2001; Geraci, 2007), our measures of prestige suggest that WEIRD participants associate prestige with wealth, status and societal positioning (Berl et al., forthcoming, see Appendix B). It is more likely that creation stories are a relevant signal of ingroup identity (Smith et al., 2017), and, thus, prestige may not have had as large an effect in this domain as the CE literature would suggest. If the transmission experiment was rerun with a different narrative genre (e.g. legal proceedings), we might find that prestige is a more influential bias.

The goal of the transmission and storytelling studies were to investigate transmission dynamics, and both have allowed us to elicit rich data that can be analysed with more fine-grained linguistic approaches in future research. Whilst we did not carry out any analysis of phonetic or phonemic features in the FPPT, the task elicits many other features that can be used to investigate CT processes. For example, I used the conversational data collected as part of the FPPT (Chapter 7) to investigate group dynamics through dominance and turn-taking (Krems, Dunbar and Neuberg, 2016; Stivers et al., 2009), and further adaptation of the FPPT could be used to study accommodation (Buller and Aune, 1992; D'Arcy and Tagliamonte, 2010; Dorjee, Giles and Barker, 2011; Dragojevic, Gasiorek and Giles, 2015; Giles, Coupland and Coupland, 1991; Muir et al., 2016). Linguistic features may be

particularly interesting considering that English is a global language (Hiraga, 2005; Jenkins, 2006; Smith and Nelson, 1985; Seidlhofer, 2005) and, therefore, there is greater variation in cultural context. These features may contribute to decision-making processes through prestige, dominance and deference (Cheng and Tracy, 2014; Henrich and Gil-White, 2001; Jiménez and Mesoudi, 2019b). The content of the conversations themselves also give insight into the decision-making process and the motivations participants have for transmitting specific information.

Variables tested in transmission studies may index other factors. For example, in the transmission study we use accent as a proxy for prestige bias, and we demonstrate in Chapters 4 and 5 that the accents we have chosen for these tasks do index differential prestige. However, accent also indexes much more information than prestige alone (Bishop, Coupland and Garrett, 2005; Brown, Giles and Thakerar, 1985; Coupland and Bishop, 2007; Fuertes et al., 2012; Giles, 1970; Kinzler and DeJesus, 2013; Kinzler, Corriveau and Harris, 2011; Lippi-Green, 1997). In the language attitude survey (Chapter 4) we see that accents are perceived differently regarding friendliness. What other traits could accent be indexing and do these traits bias transmission too? This additional confound means that it may not simply be prestige that is influencing our model choice. Considering that the transmission study and the FPPT demonstrate that people rely on different cues in selective retention and strategies in the transmission of information, we should be wary of attributing the effect of context to a single bias. Our best fitting model for the transmission experiment only explained a modest proportion of the variance, and the noise suggests that there is something not captured by our measured variables.

Motivation was a key component of CT that was not built into our studies, despite attempting to emulate realistic conditions for transmitting information and control our variables. Participants were paid in the transmission study but payment was not predicated on successful retention. We faced a dilemma: to incentivise recollection would undermine the interpretation we could make regarding selection and the biases acting on recall. By incentivising payment, we can see at a basic level the types of information people remember at all, but this is not indicative of how transmission works in reality.

We could also adapt the transmission experiment to investigate the interaction of transmission biases. We actively attempted to remove interaction by

analysing our data at the proposition level; however, some events embed multiple biases (e.g. an animal talking to another character indexes both social and counterintuitive information). Narratives may be particularly useful domain to manipulate multiple biases to determine whether biases can be hierarchical (Stubbersfield, Tehrani and Flynn, 2015) and, if so, the contexts in which this hierarchy is deployed.

Moreover, we still do not understand the extent to which the influence of these factors is conscious (Heyes, 2016, 2018; Hoppitt and Laland, 2013; Mesoudi, Whiten and Laland, 2006; Tamariz, 2019). For example, content biases that influence recollection may be unconscious, as may the cues for prestige, but do we actively choose to copy or pay attention to someone because they are prestigious? Brand and Mesoudi (2019) have recently shown that although individuals are attuned to prestige they will select individuals displaying prestige only for task-relevant information. Participants were recruited in activity-based groups and had to rate members of their group against a series of questions pertaining to prestige and dominance scales created by Cheng and colleagues (2010; 2013), and from whom they like to learn. Participants took part in a general knowledge quiz and, without knowing individuals' scores had to select someone to represent their group and compete for a prize (£500). Participants did not choose prestigious or dominant individuals but selected high-scoring individuals despite lack of access to the scores. This suggests that, although individuals are not consciously attuned to a cue, they can actively choose successful representatives, and they valued prestige less in a knowledge-based task (Brand and Mesoudi, 2019). The findings in this thesis are similar; although participants were attuned to prestige, the tasks they took part in may not be relevant for prestige. In Brand and Mesoudi's (2019) study, the impact of motivation is clear. CE research must be mindful of why transmission occurs in the first place. Many of the biases we test in CE are unconscious but individuals have active goal-oriented decision-making processes, and the impact of this is yet to be studied.

8.5 Concluding remarks

Consider a small band of academics, sharing their research findings at a 2019 conference. The next day these people disperse back to their institutions. At the next society meeting not everyone from 2019 is there and there are some new faces, and again they share their research. Some of the stories seem familiar but they are updated. Some findings seem to be innovated anew. The research presented last year has changed, determined by the experiences of the researchers since the last conference. Some papers are considerably shorter; one academic has been allotted a lightning talk and has constraints about what information she needs to get across. Other talks are longer with more detail and this benefits the new members of the group. Some people speak of their research by themselves, impromptu over coffee; others co-present or use tools like presentation software to scaffold the learning of others. Everyone takes away something; hopefully some content but sometimes just a great font to use on slides. They go off again in the morning, gathering more information and surveying what is already out there, until the next conference.

Usually when we think of storytelling, we think of genre-specific stories that have some type of linear structure and plot. However, narrative is much broader than our literary understanding. We engage in narrative on a day-to-day basis, whether through an anecdote shared by friends or the presentation of scientific research in a journal article. We use narratives to transmit different types of information and we adapt narratives to our audience and to suit our purposes. The purpose of this thesis was to build bridges between different disciplines by drawing upon multiple theories to enrich our understanding of CT. I have demonstrated the utility of applying sociolinguistic methods and theory to CT and highlighted additional factors, which are broadly ignored in transmission studies but need to be addressed. It is through a multidisciplinary approach that we can address these issues and build more realistic interpretations of CT data, and understand the motivations of these micro-evolutionary processes that shape CE.

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Appendices

Appendix A: *Comma Gets A Cure* passage

Well, here's a story for you: Sarah Perry was a veterinary nurse who had been working daily at an old zoo in a deserted district of the territory, so she was very happy to start a new job at a superb private practice in North Square near the Duke Street Tower. That area was much nearer for her and more to her liking. Even so, on her first morning, she felt stressed. She ate a bowl of porridge, checked herself in the mirror and washed her face in a hurry. Then she put on a plain yellow dress and a fleece jacket, picked up her kit and headed for work.

When she got there, there was a woman with a goose waiting for her. The woman gave Sarah an official letter from the vet. The letter implied that the animal could be suffering from a rare form of foot and mouth disease, which was surprising, because normally you would only expect to see it in a dog or a goat. Sarah was sentimental, so this made her feel sorry for the beautiful bird.

Before long, that itchy goose began to strut around the office like a lunatic, which made an unsanitary mess. The goose's owner, Mary Harrison, kept calling, "Comma, Comma," which Sarah thought was an odd choice for a name. Comma was strong and huge, so it would take some force to trap her, but Sarah had a different idea. First she tried gently stroking the goose's lower back with her palm, then singing a tune to her. Finally, she administered ether. Her efforts were not futile. In no time, the goose began to tire, so Sarah was able to hold onto Comma and give her a relaxing bath.

Once Sarah had managed to bathe the goose, she wiped her off with a cloth and laid her on her right side. Then Sarah confirmed the vet's diagnosis. Almost immediately, she remembered an effective treatment that required her to measure out a lot of medicine. Sarah warned that this course of treatment might be expensive-either five or six times the cost of penicillin. I can't imagine paying so much, but Mrs. Harrison-a millionaire lawyer-thought it was a fair price for a cure.

Appendix B: The Position-Reputation-Information (PRI) scale of individual prestige

The Position-Reputation-Information (PRI) scale of individual prestige

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Keywords: prestige, status, measurement scale, psychometrics, behaviour, cultural transmission

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1. Summary

Prestige is a key concept across the social and behavioural sciences and has been implicated as an important driver in the processes governing human learning and behaviour and the evolution of culture. However, existing scales of prestige fail to account for the full breadth of its potential determinants or focus only on collective social institutions rather than the individual-level perceptions that underpin everyday social interactions. Here, we use open, extensible methods to unite diverse theoretical ideas into a common measurement tool for individual prestige. Participants evaluated the prestige of regional variations in accented speech using a pool of potential scale items generated from free-listing tasks and a review of published scales. Through exploratory and confirmatory factor analyses, we find that our resulting 7-item scale, composed of dimensions we term position, reputation, and information, or "PRI," exhibits good model fit, scale validity, and scale reliability. The PRI scale of individual prestige contributes to the integration of existing lines of theory on the concept of prestige and, through its applications in Western contexts and its extensibility to other cultures, serves as a foundation for new theoretical and experimental trajectories across the social and behavioural sciences.

2. Introduction

Prestige is a key concept for many disciplines in the social and behavioural sciences, including psychology [1], sociology [2], anthropology [3], and economics [4]. Through its influence on the cultural transmission of knowledge and the dynamics that shape cultural diversity, prestige has been implicated as a crucial component in the evolution of our highly social species [5–8]. These cultural evolutionary dynamics ultimately arise from social interactions between individuals at the microevolutionary level. Therefore, we can consider the individual as the unit that acquires, holds, and benefits from prestige in day-to-day life. Despite the theoretical and practical importance of the prestige concept, it is surprising that no satisfactory tool currently exists for measuring individual prestige.

A scale of individual prestige that is theoretically and practically meaningful must have validity (e.g. it measures what it is intended to measure) and reliability (e.g. it is consistent in those measurements). When quantifying prestige, the scale must measure perceptions of the traits that constitute prestige and the relative influence these traits have on the general prestige construct. The scale should also assist researchers in accounting for differences in perceptions between groups of respondents—by culture, demographics, or otherwise—in order to avoid being misled by results from inappropriately aggregating across these groups [9–11]. In addition, the scale should be developed using replicable methods to allow for adaptations for use with new groups that may hold different values. Lastly, in developing the scale, researchers should endeavour to be data-driven and theory-neutral [12,13] to minimize the potential bias posed by researchers' expectations and to maximize the real-world utility and validity of the scale.

Rather than individual prestige, existing prestige scales focus on the prestige of collective social institutions or constructs, such as organizational prestige (regard for an institution, e.g. [14,15]), brand prestige (status associated with products, e.g. [16,17]), and occupational prestige (standing of professions, e.g. [18–20]), that are not directly derived from or attributable to individual-level traits. Some of the most widely-used "scales" of occupational prestige—including the NORC Duncan Socioeconomic Index [18], the Nakao-Treas Prestige Score [19], and the International Socio-Economic Index of Occupational Status [20] (and its predecessors, e.g. [21])—are not measurement tools, but rather lists of prior composite ratings for each occupation. Researchers obtained some of these

existing prestige "scales" (and others, e.g. [22,23]) by directly asking participants to rank others by their own internal concept of prestige, left undefined, or by how participants think society in general would or should rank them. These ambiguities in previous indices of prestige leave findings open to theoretically-biased interpretations [24,25].

The distinction between data-driven and theory-driven research is also relevant when considering the suitability of another published scale for measuring individual prestige: the prestige-dominance scale developed by Cheng et al. [26]. This scale was built to conform to a specific theoretical framework [27] and contrasts "prestige" and "dominance" as opposing unidimensional constructs. To maintain theoretical soundness, Cheng and colleagues chose to retain multiple scale items that did not meet their stated inclusion criteria and contributed to a poorly-fitting final model (CFI < 0.95, GFI < 0.90, RMSEA > 0.05) [26]. Here, for the purpose of developing an accurate measurement tool, we consider that the characteristics of an individual that may contribute to prestige could also overlap with those that contribute to dominance, rather than belonging to either of two fully discrete avenues to status. Previous research [28–31] suggests that peoples' mental models for one or both of these constructs may also be multidimensional rather than unidimensional. Importantly, these hypotheses can be assessed using an empirical, theory-neutral approach.

The purpose of our work is to construct a valid and reliable scale of individual prestige, as defined by participants within two broadly "Western" societies—the United States and the United Kingdom—using replicable methods that we intend to be extensible to other contexts and cultures. We take a minimal theoretical approach, elements of which have been suggested in disparate parts of the literature but never explored together in one measurement tool. Our approach makes only three fundamental assumptions about prestige:

1) Prestige can be seen as a trait possessed and used by an individual in the course of everyday social life, distinct from but not independent of the prestige accorded to the societal institutions and constructs of which they may be a part [2,25,32];
2) Prestige is based upon the subjective assessments of others, through the lens of their individually, socially, and culturally acquired beliefs, values, attitudes, and experiences [2,3,25,28,33,34]; and

3) Prestige may be composed of multiple dimensions [2,28–31,35,36], each representing differential contributions from individual, social, or cultural domains.

We made no further assumptions about what constitutes prestige or of its specific societal mechanisms and consequences, as our goal was to obtain the necessary information from respondents' own views of prestige in the real world [25]. Our approach was driven to a large degree by the responses of participants, rather than relying on any specific, theoretically-entrenched prestige concept.

One methodological challenge of our approach involved finding a valid, widely-recognized signal of prestige that could be presented to participants to evaluate the pool of prospective prestige scale items. Ideally, this instrument would also avoid pre-defining for participants what prestige means. For this purpose, and because this is one component of a larger study on prestige and the transmission of spoken information, we chose to use accented regional variation in speech to highlight differences in individual prestige. Work by sociolinguists has consistently shown that linguistic characteristics such as dialect and accent can index macro-social categories related to prestige (such as class) in the perceptions of listeners, as well as acquiring socially significant meanings of their own. Accents and regional varieties are therefore perceived as strong indicators of prestige and tend to be stable over time [37–40]. Accents are hard-to-fake signals [41] and because accents that are regarded as locally "standard" or associated with desirable upper class membership tend to be evaluated highly by a majority of listeners, they often serve as an index of membership in a high-status group [37,42,43]. Naturally, some disagreement will exist between different demographic groups on the evaluation of particular accents [37,44]. However, our focus is not on how respondents rate specific accents but on the relationships between the items used in the evaluation of prestige.

The development of a valid and reliable scale will enable researchers from diverse disciplinary backgrounds to measure individual prestige using a shared prestige concept. The scale can thus contribute to the evaluation and reconciliation of competing theories on prestige and serve as a foundation for the development of new theoretical and experimental trajectories across the social and behavioural sciences.

3. Results

The scale development process involved first constructing the prospective scale by collecting items and determining their structure through exploratory factor analysis, then evaluating the fit of the model using confirmatory factor analysis with a separate data set, and finally assessing the validity and reliability of the scale using a mixture of qualitative and quantitative criteria.

3.1. Study 1: Scale construction

We began by conducting a study to generate a pool of words or phrases ("items") related to prestige, reducing the items to those most indicative of prestige, and constructing the scale by establishing the factor structure of those items using exploratory factor analysis ("EFA"). We collected items from three sources: the most salient terms in a free-listing task completed by participants; a previously unpublished pilot study on sociolinguistic prestige; and a review of published scales that measure language attitudes and incorporated a prestige or status dimension. We also collected items from two contrasting domains—"solidarity" and "dynamism"—from published sources, to ensure that scale items adequately discriminated between prestige and other unrelated concepts with positive connotations. We used the resulting list of items (Table 1) for this study and for the follow-up scale evaluation study.

We recruited participants from the US (n = 153) and UK (n = 155) to complete an online survey using these items to evaluate the characteristics of four speakers with varying regional accents of English. As a second complementary source of data on perceptions of association between items without involving accents, participants were also asked to group the prestige domain items into like and unlike categories using a triad test.

By sequentially applying EFA and eliminating items that failed to reach the predetermined acceptance criteria (see Methods), we obtained the best-supported factor structure for the attitudinal items across all three domains (Table 2a and Figure 4), as well as the internal factor structure of the attitudinal and triad items in the prestige domain (Figure 1; Table 2b and 2c). Using EFA, items within the prestige domain were partitioned into three factors: wealthy, powerful, and high social status in the first factor, hereafter referred to as "position"; reputable and respected in the second factor, referred to as "reputation"; and educated and intelligent in the third factor, referred to as "information." We therefore denote the resulting factor structure as Position-

Reputation-Information, or "PRI." Subsequent cluster analyses on the same data generated clusters that matched the three PRI factors (Figure 6A), as did results from comparable analyses of the triad data (Figure 6B), supporting the robustness of this structure.

3.2. Study 2: Scale evaluation

We then conducted a second study with an independent data set to validate the findings of the scale construction study using confirmatory factor analysis ("CFA"). The validation step evaluates the fit of the structural model proposed by EFA and examines any potential systematic variance due to sampling [45]. We used the full set of relevant items from the scale construction study in the CFA, with three items presented in reversed form to reduce potential response bias (but this was found to be ineffective, see Methods).

For this study, we recruited a new, independent sample of participants from the US (n = 151) and UK (n = 144) to provide attitudinal ratings for a greater variety of accented speakers than in the previous study (n = 8 in each country, 4 of which were presented to participants in both countries; see Table 3), again using an online survey.

After controlling for potential differences between participant demographics, we found that the PRI model exhibited good fit (CFI = 0.959, TLI = 0.983, RMSEA = 0.031 [90% CI: 0.026, 0.036], SRMR = 0.023). Following this validation by CFA, we obtained the complete PRI scale (Figure 2).

3.3. Scale validity and reliability

The PRI scale displayed both validity and reliability in the context of our samples. Using predetermined criteria to judge the acceptability of each index (see Methods), we found support for the components of construct validity: convergent validity measures exceeded the criterion for all subscales (average variance explained, or "AVE": position = 0.670, reputation = 0.629, information = 0.696) and discriminant validity measures (heterotrait-monotrait ratio, or "HTMT": Table 6) remained below the threshold in all cases except in one comparison between internal position and information subscales. Reliability measures of internal consistency (coefficients alpha and omega: Table 7) were high within each PRI subscale (M = 0.813, SD = 0.036) and for the scale as a whole (M = 0.892, SD = 0.018). Criterion validity was demonstrated by high correlations between scale items and a separate prestigious item (M = 0.692, SD = 0.097). As added support for the criterion validity of the PRI scale, in a comparative data set

the factor scores predicted by the PRI scale were highly correlated with those of the prestige factor of the Cheng et al. [26] prestige-dominance scale (PRI overall: 0.850, position: 0.805, reputation: 0.861, information: 0.828) and the PRI scale displayed better model fit overall (ΔCFI = 0.025, ΔTLI = 0.029, ΔRMSEA = -0.045, ΔSRMR = -0.064; see Methods).

These assessments demonstrate that the PRI scale adequately represents the prestige construct and that it is distinct from the other positive traits tested (i.e. solidarity and dynamism). The three subscales (position, reputation, and information) represent cohesive parts of a whole while being relatively distinct from one another. Additionally, perceptions of the PRI structure were consistent across respondents and the scale compares well with existing prestige concepts. We take these results as support for the PRI scale as the most accurate and realistic reflection of our participants' internal views on the content and structure of the individual prestige construct.

4. Discussion

In the process of developing the PRI scale, we intentionally minimized the role of theory and allowed the structure inherent in the data—structure provided by participants' own internal conceptions of prestige and revealed through exploratory factor analysis—to dictate what was most relevant. However, in examining this structure and the constituent items of the scale after its formation, we found that the PRI prestige construct is highly consistent with different streams of prior research on prestige. The terms chosen to represent the three subscales, "position," "reputation," and "information," characterize three relatively distinct axes of individual prestige, and we examine each in turn.

The position components of the scale signify an individual's relative place in the social hierarchy, determined to a large extent by the circumstances of birth, family, and inheritance. Max Weber, in his classic theory of social stratification, argued that one's social position can be attributed to three dimensions: economic "class," or wealth; "status," or honour gained through prestige; and "party," or political power and influence [46,47]. These closely mirror the three items found in the position subscale (wealthy, high social status, and powerful) and this finding reflects the continuing utility of Weber's ideas in sociological theory and practice [48].

The items in the reputation subscale (reputable and respected) relate to social opinion and esteem and are terms frequently used to describe prestige (e.g. [14,15,27]), and are even used synonymously with it (e.g. [49]). In the sociological

literature on prestige, reputation and respect have the connotation of a collective judgment of character independent of individual variation in judgments [2]. Reputation and respect represent the general societal evaluation of an individual in a certain position or role, subjectively interpreted through social and cultural values. By contrast, the items in the position subscale may be established through privilege without necessarily undergoing the same degree of collective evaluation [46,47].

The third subscale, information, and its items (educated and intelligent) represent the value placed by society on the holders of wisdom, expertise, and learning. These constructs are supported by the occupational prestige literature, which emphasizes that—in a stratified society with specialized occupations—an individual's educational background and achievement are highly predictive of their future occupational class which, in turn, contributes significantly to individual prestige (e.g. [50–52]). The salience of this subscale and its focus on information holders could also indicate support for arguments from information theory about the evolution of prestige and its role in cultural transmission. The information theory-based account, presented alongside (but not integral to) the dichotomous prestige-dominance distinction by Henrich & Gil-White [27], asserts that individuals gain prestige by having desirable skills and knowledge that others compete within a social group for the opportunity to learn. Alternatively, an occupation attained through greater education could be another avenue to wealth and power. This question, and to what extent—if any—some form of the information subscale would be relevant to prestige across the diversity of non-Western or non-industrialized societies remains open to future study.

Indeed, there is a great need to explore concepts of prestige cross-culturally to reach beyond the perspectives given by Western and westernized participants. Many existing prestige indices have been explicitly promoted for their universality, in spite of having been developed using data almost exclusively from "WEIRD" (Western, Educated, Industrialized, Rich, and Democratic) societies [53] in the 1960s, '70s, and '80s. The utility of these indices across cultures and over the significant span of time and sociocultural change that has occurred since they were developed has been called into question [9–11,28,54].

The concept of prestige, the individual components that comprise prestige, the degree of importance attached to each component, and the relationships between components are all—to some degree—culturally constructed and malleable through cultural evolutionary processes. Therefore, we recognize that

the PRI scale is not universally applicable, as this is an unrealistic expectation. We developed the PRI scale using data collected from adults in the highly WEIRD societies of the United States and United Kingdom and it should not be generalized beyond that context without adequate validation. The high degree of consistency in the PRI structure across our representative samples of demographically diverse participants in the US and UK suggests that the PRI scale should function well across other highly Westernized, English-speaking societies (for a sample form, see supplementary material Form S1). However, distinct demographic or cultural groups within these societies may hold different values and have substantially different internal models of prestige. For these reasons, and in the interest of following best practices in psychometrics [55], we strongly recommend testing the validity and reliability of the PRI scale with each application and testing for invariance across as many demographic variables as may be potentially relevant.

We have made the process of constructing and validating the PRI scale extensible to any additional population for which a scale of individual prestige is needed, through the emphasis on the participants in the item generation and evaluation stages, the use of straightforward and appropriate methods and criteria, the use of open-source analytical tools, and the open sharing of all data and code used to run analyses (see supplementary material Data S2). A new variant of the PRI scale can be constructed by repeating these methods in a new group, with awareness and care for local cultural norms and power structures. Examining systematic differences in responses and extending the PRI scale to other contexts and cultures can further improve the representation and inclusion of minority and non-Western perspectives on prestige, and we argue is the most important avenue for future research presented by this study.

The PRI scale for the measurement of individual prestige fills a crucial niche by establishing a measurement tool driven by the real-world perceptions of individuals across two Western societies. The PRI scale enables the study of prestige—a central yet divisive concept throughout the social and behavioural sciences—using a common foundation, which we hope will encourage fruitful engagement, conversation, and collaboration that spans across disciplinary boundaries. We have shown the broad utility of this scale for conducting research by finding support for the PRI structure in both of two separate sources of data: attitudinal responses to variations in accented speech, and triadic conceptual associations absent the sociolinguistic context.

Future research should endeavour to untangle the complex and varied patterns in how prestige is perceived and how it operates in the practice of real social interactions across the breadth of human experience. The availability of the PRI scale allows researchers to explore in greater detail the relationships between different aspects of prestige, dominance, status, and success. Some of these relationships may be quite complex, or even circular, as suggested by the presence of high social status as an indicator of prestige within the position subscale (whereas scholars would normally consider prestige to be a contributor to status) or by the possible contributions of specific indicators like educated toward other indicators like wealthy. Additionally, there may be some degree of overlap between the construct of prestige, as measured by the PRI scale and the prestige factor of the Cheng et al. [26] prestige-dominance scale, and other related concepts like dominance and leadership. Many questions remain about the breadth and interconnectedness of the varied routes to the acquisition of social status. We view the establishment of the PRI scale as a necessary step toward a more integrated and comprehensive understanding of prestige, through the clarification of preceding debates and the beginning of new lines of inquiry into the core concepts that shape interactions, relationships, social structure and inequality, and the evolution of culture.

5. Methods

5.1. Study 1: Scale construction

5.1.1. Item generation

In the development of this scale, we used a combination of deductive and inductive methods to collect the items most relevant to the concept of individual prestige. This methodological approach incorporated emic, operational determinants of prestige from a real-world Western context, as well as shared items from previous scales, in order to evaluate all possible components of a prestige scale concurrently. We sampled items from a salience analysis of responses to a free listing task, from existing attitudinal scales in the literature, and from responses to a pilot study investigating sociolinguistic prestige. We favoured the use of inductive methods, specifically the free listing task, because they are generalizable and facilitate replication and extension to other contexts and cultures.

Free listing is a tool from cultural domain analysis used to elicit responses on a particular classification of knowledge [56–58]. The task conducted as part of this study consisted of a survey in which participants responded to the following three prompts, in order:

List all of the words or phrases that you can think of that are related to "prestige."

List all of the words or phrases that you can think of that describe "prestigious" people.

List all of the characteristics that you can think of that make a person "prestigious."

Responses were limited to 2 minutes per question. We allowed repetition of terms from prior questions, but participants could not refer back to previous responses. We recruited participants for this task through advertisements in local undergraduate courses (n = 6 US) and social media networks (n = 42 US, 20 UK), for a final sample of 68 participants. We compensated undergraduate students for their participation and social media participants engaged voluntarily. Participants ranged in age from 18 to 50 (M = 28.9, SD = 7.3), with 18 that identified as male and 50 that identified as female. All participants were native English speakers. All participants self-identified as white, except for one person of mixed ethnicity from the US and one person of colour from the UK. Participants came from a variety of backgrounds with respect to the size of their childhood settlement and educational attainment, but for occupation most were either students (25.0%) or were in management or professional positions (26.5%), with others in service (11.8%) and sales (5.9%) positions.

After obtaining the three free lists of items from each participant, we grouped items for common meaning, reducing the pool of unique items from 717 to 303. Generally, this procedure consisted of replacing multi-word phrases with single-word synonyms and converting words to adjective form (e.g. "lots of education" to "educated" and "influence" to "influential"). We left given terms as-is if their intended meaning was ambiguous. On the whole, groupings were done with the intent of minimal replacement, so as to allow participants to speak for themselves, and all co-authors verified the groupings. We then calculated a salience value for each of the 303 items using Smith's S [59], which takes into account both the frequency of an item's occurrence across lists and order of occurrence within lists. From a scree plot of the items by their salience values, we chose the cutoff near the inflection point at the highest local proportional drop in salience (0.0148) to capture the set of most salient items (Figure 3) [56]. The items

retained from this exercise were: wealthy, high social status, powerful, respected, educated, hardworking, and successful.

Given the use of attitudes toward regional accents as a measurement tool in this study, and in the interest of full coverage of the domain of interest (i.e. content validity), we chose to supplement the pool of potential scale items by reviewing items used in established scales of language attitudes that incorporated a prestige or status dimension. The two scales we selected for this purpose were the Speech Dialect Attitudinal Scale ("SDAS": [60]) and its revised version ("SDAS-R": [61]) and the Speech Evaluation Instrument ("SEI": [62]) and its short form version ("SEI-S," as used by [63]). The following items were represented in some form within both scales under a dimension of "prestige," "status," or "competence" and were therefore retained: wealthy, high social status, educated, and intelligent (as a note, we collapsed upper class into the broader high social status and literate into educated). These items agreed closely with those used in other sociolinguistic studies for these dimensions [40], and therefore can be regarded as representative of the literature. We also collected items from the selected scales to represent two other domains commonly used in speech evaluation studies [37,40]: "solidarity" and "dynamism." We included these domains, which are unrelated to prestige but similarly positively valenced, to assess the ability of prestige items to represent prestige itself and not merely a positive evaluation of the speaker (i.e. discriminant validity). The additional items we selected were: friendly, kind, good natured, warm, and comforting for the "solidarity" dimension, and aggressive, active, confident, and enthusiastic for the "dynamism" dimension. One item, clear, was also initially included within "dynamism," but we later removed it from analyses due it clustering more closely with items in other dimensions.

A third and final source of items was a previously unpublished pilot study that we conducted on speech, accent, and prestige in October and November of 2015. The sample of this pilot study consisted of 100 US and 44 UK participants (undergraduate and graduate/postgraduate students) ranging in age from 18 to 64 years (M = 21.8, SD = 5.3). Of the participants, 47 identified as male and 95 as female. The majority of participants, 141, identified as native English speakers, with 2 non-native speakers. Participants were asked to rate two speakers—one with a locally standard accent (US or UK) and the other with a nonstandard accent—on 15 attitudinal items using a 7-point Likert-type scale. The items in this pilot study were also drawn from prior linguistic studies. Following exploratory factor analysis and the sequential elimination of items following the same criteria

described below for the present study, as well as examining inter-item correlations with a prestigious item to find the most closely associated items, we retained the following items from the pilot study: hardworking, reputable, intelligent, and ambitious.

The combined pool of items retained from all three sources (Table 1) were then used in the scale construction and scale evaluation studies to establish and verify the scale.

5.1.2. Questionnaire construction and administration

We developed an online questionnaire for use in the United States and United Kingdom using the pool of attitudinal items retained from the item generation stage.

For the stimulus, we presented each participant with four audio recordings of the same short passage (approximately 30 seconds in length), each read by a speaker with a different regional accent of English, and asked them to rate each speaker on all 20 attitudinal items using a 7-point Likert-type scale from low (1) to neutral (4) to high (7). All recordings consisted of the first paragraph of Comma Gets a Cure (see Acknowledgements), a passage which uses the Wells Standard Lexical Sets for English [64] to highlight the most differentiable elements of accents.

We selected accents from the dialect regions defined by Labov et al. [65] for the United States and Shackleton [66] for the United Kingdom. The US-based accents in this study were American West and Inland South and the UK-based accents were Received Pronunciation ("RP") and Northwest England. We recorded a speaker from urban Colorado to represent the American West accent, and for the other three accents we used recordings under license from the International Dialects of English Archive ("IDEA"; see Acknowledgements). A full list of the recordings used and speaker demographics is available in the supplementary material (Table S4).

The IDEA data sources predominately represented white male speakers. As a result of controlling for speaker demographics and audio quality from the available recordings, our speakers all self-identified as white males ranging from 42 to 59 years old. In the sociolinguistic sense, American West (which phonologically is in the spectrum of the "General American" accent) and Received Pronunciation represent standard or "high-prestige" variants within the US and UK, respectively, and Inland South and Northwest England are

nonstandard "low-prestige" variants [67,37,38]. The American West and RP speakers used for this study held university degrees and the Inland South and Northwest England speakers did not. The American West and RP speakers were employed in professional teaching occupations and the Northwest England and Inland South speakers were employed in skilled trades. Therefore, their educational and occupational attainment matched the indexical class and status associated with their accents. We presented all participants with all four recordings, regardless of their location.

Prior to being presented with the recordings or giving attitudinal responses, participants each completed a triad test [56] with a lambda-3 balanced incomplete block design [68] for the 11 prestige domain items, resulting in 55 triadic comparisons per participant. In each comparison, participants chose which of the three items was perceived to be least like the others, thereby creating a pair of like items. This could be used to assess whether the perception of the structure of prestige items was consistent beyond the sociolinguistic context of the prestige of regional accents.

We collected a number of demographic variables from participants, to be able to examine any systematic differences in responses. The demographic variables chosen were: country, age, gender, ethnicity, locality size, English proficiency, education, occupation, and income. Each variable and its levels are described in detail in the supplementary material (Metadata S3) and their distributions within the sample are displayed in Figure 7 in comparison with those of the subsequent scale evaluation study.

We collected data in May and June 2016 using online surveys implemented on SurveyMonkey and distributed using social media (n = 5 US, 2 UK), the Amazon Mechanical Turk and TurkPrime [69] platforms (n = 148 US), and the Prolific platform (n = 153 UK), for a final sample of 308 (153 US, 155 UK). There were 5 participants (4 US, 1 UK) that completed the triad test but not the attitudinal speech evaluation, so the final sample for the attitudinal data was 303 (149 US, 154 UK). There were otherwise no missing attitudinal or triad data, as we required participants to complete every item in order to receive payment.

5.1.3. Exploratory factor analysis

First, we checked the data for conformity to the assumptions of exploratory factor analysis ("EFA"). Though strict multivariate normality is not required for exploratory or confirmatory methods using categorical models, and violations are allowable under continuous models (i.e. maximum likelihood) if

measurement invariance is established [70], we found that the distribution of responses to the attitudinal items was not multivariate normal ($p \cong 0$ for Mardia's test [71,72], Henze-Zirkler test [73], and Royston's test [74,75]). We identified multivariate outliers using adjusted chi-square quantile-quantile plots of Mahalanobis distances and removed one participant (from the US sample) with extreme outlier values.

We then assessed the distributions of attitudinal items for approximate univariate normality, as well as for acceptable values of skewness and kurtosis. Following [76], absolute values of skewness below 0.5 indicated an approximately symmetric distribution, values between 0.5 and 1.0 were considered moderately skewed, and values above 1.0 were highly skewed. According to the findings of West et al. [77] and Curran et al. [78], issues of bias due to non-normality may result from the analysis of data distributed with absolute skewness values above 2.0 or kurtosis values above 7.0. We found individual variables to be approximately normal and values of skewness ($M = -0.242$, $SD = 0.407$) and kurtosis ($M = -0.536$, $SD = 0.476$) to be within acceptable ranges.

We evaluated linear relationships between items and their factorability by examining inter-item correlations, using the Kaiser-Meyer-Olkin ("KMO") test of sampling adequacy [79], with values greater than or equal to 0.50 considered suitable [80,45,81], and using Bartlett's test of sphericity [82] to test whether the correlation matrix was factorable. We calculated a polychoric correlation matrix because attitudinal items were measured using an ordinal scale [83]. Following Savalei [84], no adjustments were made to zero frequency cells in the bivariate tables. A large proportion of inter-item correlations (73/210, or 34.8%) were above 0.50, indicating the presence of linear relationships. KMO values were well above 0.50 for all variables (overall = 0.946, $M = 0.935$, $SD = 0.039$) and the result of the Bartlett's test was highly significant ($p \cong 0$), together indicating suitable factorability.

Lastly, we evaluated whether our sample sizes were adequate, using the guidelines of having a total sample size of at least $p(p-1)/2$ [85], where p is the number of items or variables, and a subjects-to-variables ratio of at least 10:1 [80] or 20:1 [45]. The sample size for this study (after outlier removal) was 302, which (at $p=20$) exceeds the suggested minimum of 190, and the subjects-to-variables ratio was 15.1:1, which lies above the recommendation of 10:1 and below 20:1.

We then conducted exploratory factor analysis for the purpose of exploring the structure and dimensionality of the prestige construct. Our

analyses used a three-stage robust diagonally weighted least squares estimation technique (weighted least squares, mean and variance adjusted, or "WLSMV") due to its suitability for use on ordinal data with an adequate number of categories [85–87]. We used a conservative oblimin (oblique) factor rotation method to allow for potential intercorrelations between factors, which may be expected in real-world attitudinal data [88].

We eliminated items sequentially, first to remove items that had poor value in discriminating the prestige domain from the other two domains included—solidarity and dynamism—and then to determine the most parsimonious structure within the prestige domain. Items needed to meet all of the following acceptance criteria to be retained: a) primary factor loading with an absolute value > 0.32; b) cross-loadings with absolute values < 0.32; c) gap between primary and cross-loadings > 0.2; and d) communality > 0.4 [89]. We re-evaluated the optimal number of factors at each step using the parallel analysis with comparison data method of Ruscio & Roche [90].

Through this process, we obtained the overall factor structure for the attitudinal items across all three domains (Table 2a; Figure 4), as well as the internal factor structure of the prestige domain items (Table 2b; Figure 1). Using EFA, items within the prestige domain were partitioned into three factors: wealthy, powerful, and high social status in the first factor, hereafter referred to as "position"; reputable and respected in the second factor, referred to as "reputation"; and educated and intelligent in the third factor, referred to as "information." We therefore denote the resulting factor structure as Position-Reputation-Information, or "PRI."

After completing EFA using the attitudinal data, we then repeated the process using the data from the triad test as a second, parallel source of information on the structure of the prestige construct absent the embedded sociolinguistic context. Since the pairings in the triad data are represented as a series of dichotomous observations, we calculated a tetrachoric correlation matrix [91], using a correction of 0.5 for empty bivariate cells (following Savalei [84]) and eigenvector smoothing to ensure the matrix was positive definite. We chose related methods to maximize comparability between the attitudinal and triad data sources. We used a non-robust weighted least squares ("WLS") estimator with standard parallel analysis and identical acceptance criteria to those used for the EFA of the attitudinal data described above.

The inter-item correlations between triad items had 4/55 (7.3%) above 0.50. The overall KMO value was 0.364 (M = 0.368, SD = 0.160), with the lowest

individual values being successful at 0.075 and powerful at 0.157, and the highest being wealthy at 0.585. While the result of the Bartlett's test was highly significant ($p \cong 0$), it is also dependent upon sample size, which was reasonably large ($n = 308$). Taken together, these results suggested that factorability could be poor due to the nature of how the data were represented; specifically, the triadic comparisons generated a matrix with a large amount of "missing" data, as only 3 items in each observation (out of 11 total) had values. The sample size for the triad data was much higher than the suggested minimum of 45 in this case (given the lower number of items), and the subjects-to-variables ratio was 30.8:1, which is above both recommended values. We obtained the internal factor structure for the prestige domain items in the triad data (Table 2c) using the EFA methods described. The structure closely resembled the attitudinal results in all respects except that powerful was dropped from the position factor due to negative loadings and low communality.

5.1.4. Cluster analysis

Following the EFA for both the attitudinal data and the triad data, we also elected to conduct cluster analysis on the items in both data sets to compare results with the EFA findings on the internal structure of the prestige construct. Though the outputs of EFA and cluster analysis are qualitatively similar, the two methods have substantively different goals (dimensionality reduction to latent constructs versus classification to subgroups, respectively) and algorithms. We chose the Partitioning Around Medoids ("PAM") method [92], a type of k-medoids algorithm in the k-means family, due to its flexibility in accommodating various dissimilarity measures and its robustness against outliers. For the attitudinal data, we used Manhattan distances rather than Euclidean due to their suitability for ordinal data [92]. Visual examination of the Manhattan distance matrix using multidimensional scaling suggested that the attitudinal data were amenable to cluster analysis.

We eliminated items sequentially to remove items with poor discriminant value and to determine the internal prestige structure, retaining items which had a positive silhouette width of at least 0.1 and the removal of which did not substantially improve the overall clustering structure (as measured by average silhouette width of the solution). The silhouette width of an item represents the relative consistency of that item within its cluster. At each step, we used the Duda-Hart test [93] to determine whether more than one cluster was supported

and the number of clusters was determined by the highest average silhouette width.

The PAM method resulted in a 2-cluster solution for all attitudinal items (Figure 5) and a 3-cluster solution for the internal prestige domain items (Figure 6A). The average silhouette width of the 2-cluster solution for all items was 0.428, while the next highest, at 4 clusters, was 0.294. For the internal prestige domain items, the average silhouette width of the 3-cluster solution was 0.282, with 0.300 for 2 clusters. However, the Dunn index, or the ratio of minimum inter-cluster distance to maximum intra-cluster distance [94], was 1.052 for the 3-cluster internal solution and 0.882 for the 2-cluster internal solution, indicating that the 3-cluster solution has better validity. These results support the 3-cluster solution for the internal prestige domain items and this solution matches exactly the PRI structure found through EFA.

Applying the PAM method to the triad data gave similar results, with the highest average silhouette width overall (0.388) found for a 3-cluster solution that matched the PRI structure (Figure 6B). However, we reached this solution by eliminating the hardworking and ambitious items based on information from the EFA showing their poor fit within the prestige domain. The triadic comparisons included only prestige domain items so, within the context of the triad data alone, this information about the ability to discriminate from other domains would be unavailable. Additionally, the Dunn index suggested better support for this 3-cluster solution (1.112) than for a 4-cluster solution that included hardworking and ambitious (1.051). These results are consistent with what we found from the attitudinal data and replicate the PRI structure in the best-fitting solution.

5.2. Study 2: Scale evaluation

5.2.1. Item generation

We used the full set of items generated for the previous scale construction study (Table 1) for evaluation and validation of the scale. We selected three additional prestige items (talented, driven, and skilled) from those generated by the free listing exercise to explore whether the inclusion of additional terms would have any effect on the PRI structure or provide additional explanatory power. As a number of the existing terms could be interpreted as measures of "ascribed" prestige (i.e. traits that are largely assigned or fixed based on the circumstances of

one's birth), we chose these terms as representative of the concept of "achieved" prestige (i.e. traits that can be earned or acquired) [33].

We also reverse-scored three items (intelligent-unintelligent, ambitious-unambitious, and kind-unkind) to reduce potential bias in responses [95], selected intentionally to avoid potentially ambiguous reversals. However, during exploratory analyses, we found that the distributions of responses to the reversed items were significantly skewed toward higher values than for the same items in the scale construction study. This suggests that participants were less likely to agree with a negative assessment of a speaker (i.e. unintelligent) than they were to disagree with its opposite positive assessment (intelligent). These differences caused issues with the consistency of responses and negatively affected model fit, similar to the problems seen later with reversed items in the Cheng et al. [26] scale (see Criterion validity) but to a lesser degree. Due to these issues, we do not recommend reversal for future studies using attitudinal items scored on a Likert-type scale (cf. [96]).

5.2.2. Questionnaire construction and administration

In the online questionnaire for the scale evaluation study, we presented each participant with 10 audio recordings of the same passage used in the scale construction study: the first paragraph of Comma Gets a Cure. Each recording used a speaker with a different regional accent of English, and we asked participants to rate each speaker on all 23 attitudinal items (Table 1, plus talented, driven, and skilled under prestige) using a 7-point Likert-type scale from strongly disagree (1) to strongly agree (7).

We presented participants in the US with 8 US-based accents and 2 UK-based accents, while participants in the UK were presented with 8 UK-based accents and 2 US-based accents, for a total of 16 different accents across the entire sample, 4 of which were cross-tested in both countries (Table 3). The recordings for the 4 cross-tested accents were identical to those used in the scale construction study. All recordings were used under license from IDEA (see Acknowledgements) except for American West (Urban) and Wales, which we recruited from local contacts and recorded.

As in the scale construction study, we selected speakers for consistency from the recordings available. All speakers self-identified as white men and ranged in age from 31 to 59 years. Speakers varied in their level of education, occupation, and settlement size during childhood. The speaker from Wales was 45 years old at the time of recording, held an advanced degree, and was

employed in an academic profession. The demographics of the American West (Urban) speaker are given in the methods for the scale construction study and all speaker demographics are available in the supplementary material (Table S4).

We collected data in June 2016 using online surveys implemented on SurveyMonkey and distributed using Amazon Mechanical Turk and TurkPrime [69] (n = 151 US) and Prolific (n = 144 UK), for a sample size of 295. We excluded participants from the prior scale construction study to ensure an independent sample. The results did not contain any missing data for attitudinal items.

5.2.3. Demographic comparisons

Demographic characteristics of the scale evaluation sample were similar to the scale construction sample (Figure 7). Permutation tests of independence [97], adjusted for multiple comparisons to control for the false discovery rate, confirmed that significant differences were present only in the distributions of the age ($p < 0.001$) and occupation ($p < 0.001$) variables between the two studies, as a result of a larger proportion of relatively younger students in the scale evaluation sample. Given the similarity across all other variables, we considered this to be a relatively minor issue, and one that could be checked analytically by examining measurement invariance (see Confirmatory factor analysis).

5.2.4. Exploratory factor analysis

Following checks of assumptions, outliers, item relationships, item factorability, and sample size, we conducted EFA on the scale evaluation data using methods and criteria identical to those used in the scale construction study, to address the question of whether the items generated adequately represented the breadth and structure of the individual prestige concept. The items that were previously eliminated in the EFA of the scale construction study were eliminated again in the process of conducting this EFA, due to violations of acceptance criteria. All three additional "achieved" prestige items—talented, driven, and skilled—were also eliminated, particularly because of high cross-loadings or primary loadings on other factors. We therefore made no changes to the structure of the model or the items included and found the scope of the existing PRI model to be adequate for use in CFA.

5.2.5. Confirmatory factor analysis

The distribution of responses to the attitudinal items was not multivariate normal ($p \cong 0$ for all tests). We removed four participants with six extreme outlier values

(all from the US sample) as a result of examining Mahalanobis distances, leaving a final sample size of 291. The individual variables were approximately normal, and values of skewness (M = -0.209, SD = 0.369) and kurtosis (M = -0.617, SD = 0.279) were within acceptable ranges.

We then performed measurement invariance testing [98], to ensure that the relationships between indicators and latent variables within the prestige construct were consistent across participant demographic groups by country, age, gender, ethnicity, locality size, educational attainment, occupation, and income (see supplementary material Metadata S3 for details on demographic variables). The sample contained an insufficient number of non-native English speakers to test for invariance by native English proficiency; therefore, we excluded this variable. We tested five increasingly constrained models in sequence: configural invariance (Model 1), metric or "weak" invariance (Model 2), scalar or "strong" invariance (Model 3), residual or "strict" invariance (Model 4), and residual invariance with constrained means (Model 5). We established configural invariance using the permutation method proposed by Jorgensen et al. [99]. We looked at changes in two noncentrality-based fit indices, the Comparative Fit Index ("CFI") and the Root Mean Square Error of Approximation ("RMSEA"), to evaluate the relative fit of each successive nested model, with ΔCFI values less than or equal to 0.010 and ΔRMSEA values less than or equal to 0.015 indicating invariance [100]. Fulfilment of scalar invariance was considered sufficient to proceed with confirmatory factor analysis [98].

Measurement invariance of the model was upheld across the demographic variables of country, age, gender, occupation, and income. We found metric non-invariance by locality size (ΔCFI = 0.011, ΔRMSEA = 0.030), and ethnicity and educational attainment were borderline metric non-invariant (ΔCFI = 0.007, ΔRMSEA = 0.022; and ΔCFI = 0.009, ΔRMSEA = 0.026, respectively). Given these results, we defined a complex survey design which re-fit the model using pseudo-maximum likelihood and provided adjusted point and variance estimates [101,102]. In this design, the potentially non-invariant demographic variables were incorporated as weighted sampling strata using weights approximated from US [103–105] and UK census data [106–108].

We then performed confirmatory factor analysis ("CFA") to assess the fit of this model to the scale evaluation data. As the WLSMV estimation method used in previous analyses could not be applied to a complex survey design, we used maximum likelihood with robust standard errors (mean and variance adjusted using the Satterthwaite approach [109], "MLMVS") for the CFA based

on the complex survey design. Equivalent results should be obtained from either method, as the two perform comparably for 7-point ordinal data [87].

We assessed the goodness of fit of confirmatory models with and without the complex survey design using two incremental fit indices (the CFI, as above, and the Tucker-Lewis Index, or "TLI") and two absolute fit indices (the RMSEA, as above, and the Standardized Root Mean Square Residual, or "SRMR"). We drew cutoff criteria from Hu & Bentler [110] and adjusted them to the recommendations of Yu [111] as follows: CFI > 0.95; TLI > 0.96; RMSEA < 0.05; and SRMR < 0.07. We obtained parameter estimates using both robust maximum likelihood and robust weighted least squares methods, and compared fit indices for the models using MLMVS estimation, MLMVS estimation with a complex survey design, and WLSMV estimation (Table 4).

All three models shared the identical PRI structure and had comparable fit indices. We selected the model using MLMVS with adjustments from the complex survey design as the preferred model (Figure 2) because it fulfilled the cutoff criteria for all fit indices and properly incorporated information on all potentially non-invariant demographic variables.

5.3. Scale validity and reliability

5.3.1. Content validity

Content validity is the assessment of whether the scale adequately represents the extent of the domain of interest. As content validity is essentially a qualitative judgment rather than a statistical one [55], we worked to establish and report the content validity of the PRI scale through the methods used to generate the items and those used to construct and verify the scale.

As mentioned previously, items were generated in part by participants through an inductive, endogenous process in the free listing task, which produced a broad but consistent sample of items. We supplemented this with more traditional deductive sampling of terms from previous literature and a pilot study. Rather than consulting external subject matter experts (cf. [112]), we valued more highly the validity of judgments by the study participants in generating and associating items.

Additionally, we included three "achieved" prestige items (talented, driven, and skilled), drawn from the free listed terms, to confirm the content validity of the model being tested. These items (and all of the same items dropped previously from the scale construction study) were dropped due to

failure to meet the acceptance criteria, which lends support to the validity of the PRI scale and the sufficiency of its domain breadth.

Finally, we considered that the relative lack of demographic diversity among free listing participants in the initial scale construction study (compared to that of our other samples) could have negatively impacted the breadth of items generated and hence the content validity of the scale. However, we found no specific evidence to suggest this was the case, aside from potential issues of measurement non-invariance (see Confirmatory factor analysis) which could have occurred regardless. We therefore do not consider this to have been a point of concern for the present study but would recommend future studies endeavour to recruit a maximally diverse and representative sample from the population of interest for item generation.

5.3.2. Construct validity

Construct validity is the property that the scale measures what it is intended to measure, which is generally confirmed by showing correlations among elements expected to be similar ("convergent validity") and a lack of correlation among elements expected to be dissimilar ("discriminant validity"). The construct validity of the PRI scale was established by examining the convergent validity of scale items, the discriminant validity between PRI subscales (position, reputation, and information), and the discriminant validity between the prestige scale and the other two domains included in the data (solidarity and dynamism).

We assessed convergent validity within the scale by examining the polychoric correlation matrices of the scale items in both studies and the average variance explained ("AVE") of the scale items in the scale evaluation study. Following common practice, correlation coefficients between 0.10 and 0.30 were considered small, between 0.30 and 0.50 were moderate, and greater than 0.50 were large [113]. AVE values greater than 0.50 were deemed acceptable, as they indicate sufficient variance attributed to the construct as opposed to measurement error [114].

We found polychoric correlations (ϱ) between all PRI scale items to be high ($M = 0.631$, $SD = 0.094$) and correlations were higher between items within the same subscale than between items in different subscales (Table 5). The AVE values for each of the three subscales—position, reputation, and information—were 0.675, 0.630, and 0.699, respectively; all were above the criterion of 0.50, supporting convergent validity.

The discriminant validity of constructs, which naturally opposes convergent validity, was assessed using the heterotrait-monotrait ratio of correlations criterion ("HTMT"), a method developed to avoid the potential issues of other indices [115]. For this criterion, lower values indicate greater discriminant validity. HTMT values between the prestige PRI subscales and the other two constructs—solidarity and dynamism—were all below the cutoff of 0.85 advised by Voorhees et al. [116], verifying discriminant validity of the prestige construct (Table 6). Similarly, HTMT values showed good discriminant validity between the three PRI subscales. This shows that the three PRI subscales, along with showing good convergent validity (as their items are all measuring elements of the same prestige construct), also exhibit substantial discriminant validity from other constructs and from one another. We consider these results to be support for the PRI scale's overall construct validity and simple structure.

5.3.3. Criterion validity

The criterion validity of a scale relates to its ability to be used as a measurement tool for the construct of interest, either assessed concurrently with a direct measure of that construct, in comparison with other available tests, or as a predictive indicator of independent or future outcomes. Predictive validity could not be assessed in this instance, as we did not have any future measurements or any independent prestige-related traits that were not already used in scale construction and evaluation, so we assessed the concurrent criterion validity of the scale through the other two avenues.

We first compared each item's polychoric correlation with the prestigious item. The prestigious item was included in the surveys but excluded from the scale, and was used as a direct representative of the general construct of prestige that we intended to measure. In the scale evaluation data set, polychoric correlations between scale items and the prestigious item were high overall ($M = 0.678$, $SD = 0.104$), as were mean correlations with prestigious within each of the PRI factors (position: $M = 0.748$, $SD = 0.096$; reputation: $M = 0.626$, $SD = 0.026$; information: $M = 0.627$, $SD = 0.143$). Estimated factor scores for each PRI factor (using the Empirical Bayes Modal approach [117] for ordinal variables and the MLMVS model with adjustments from the complex survey design) were even more highly correlated with prestigious than the raw item scores (PRI individual prestige: $\varrho = 0.815$; position: $\varrho = 0.844$; reputation: $\varrho = 0.764$; information: $\varrho = 0.745$).

Secondly, to compare with another test of prestige, we asked a new set of participants (n = 91 US, 53 UK; again recruited through Amazon Mechanical Turk and Prolific) to rate two new speakers (having the Inland South and Received Pronunciation accents) using the present scale alongside the prestige-dominance scale of Cheng et al. (as detailed in the Electronic Supplementary Material of [26]). We modified the text of the items in the Cheng et al. scale (from "members of your/the group" to "people") to better fit the context of our study. We removed outliers from the data and, using the same methods as above (with WLSMV estimation for the Cheng et al. scale data as the previous estimation method was not specified [26]), calculated factor scores for the PRI subscales, the solidarity and dynamism dimensions, and the prestige and dominance factors from the Cheng et al. prestige-dominance scale. We calculated polychoric correlations to examine the level of agreement between these measures.

In this additional comparative data set, we found substantial correlations between factor scores of the PRI scale and the prestige factor of the Cheng et al. scale (PRI overall: ϱ = 0.850, position: ϱ = 0.805, reputation: ϱ = 0.861, information: ϱ = 0.828) and, in general, we found that the individual prestige items of each scale were correlated (M = 0.567, SD = 0.221). However, one item in particular from the Cheng et al. scale (item 17: "Other people do NOT enjoy hanging out with him") was relatively uncorrelated with PRI items and with the other Cheng et al. prestige items. Notably, this is one of the three reversed items in the Cheng et al. prestige factor, the other two of which (items 2 and 6: "People do NOT want to be like him" and "People do NOT value his opinion") had only moderate correlations with PRI items and other Cheng et al. prestige items. The removal of all three reversed items had little effect on correlations between the Cheng et al. prestige factor and the PRI subscales (PRI overall: ϱ = 0.856, position: ϱ = 0.810, reputation: ϱ = 0.867, information: ϱ = 0.832) but improved the mean correlation between individual items (M = 0.690, SD = 0.066).

The reversed items contributed to the poor fit of the Cheng et al. scale overall in this data set (CFI = 0.875, TLI = 0.856, RMSEA = 0.229 [90% CI: 0.219, 0.238], SRMR = 0.154; using WLSMV estimation). The model fit improved with the removal of all reversed items (CFI = 0.973, TLI = 0.966, RMSEA = 0.151 [90% CI: 0.137, 0.165], SRMR = 0.083), but remained unacceptable under criteria for the two absolute fit indices, RMSEA and SRMR. We found the fit of the PRI scale using the same data and estimation method (WLSMV) met the cutoffs for all indices except RMSEA (CFI = 0.998, TLI = 0.995, RMSEA = 0.106 [90% CI: 0.075, 0.139], SRMR = 0.019). Notably, polychoric correlations between—first—the

factor scores for dominance in the Cheng et al. scale (reversed items removed) and—second—the Cheng et al. prestige factor scores, the prestigious item, and the PRI factor scores, were all moderate to high (Cheng et al. prestige: $\varrho = 0.449$, prestigious: $\varrho = 0.561$, PRI prestige overall: $\varrho = 0.533$, position: $\varrho = 0.569$, reputation: $\varrho = 0.489$, information: $\varrho = 0.501$), which may indicate issues with the validity of the dominance construct.

5.3.4. Interrater reliability

In these studies, we did not expect participants to rate each speaker identically for each item, nor is such agreement required to obtain a reliable scale of individual prestige. As mentioned in the Introduction, prior work has shown that different demographic groups will evaluate accents differently. By testing and adjusting the fit of the confirmatory model, we already incorporated information on patterns of variation in item ratings, both by individual and between demographic groups. Our results showed that participants displayed a consistent understanding of the overall prestige construct regardless of disagreements about particular speakers. This being said, measures of interrater reliability can be obtained and so we provide them here for completeness.

We calculated Krippendorff's alpha coefficient [118] using ordinal weights, as well as the intraclass correlation coefficient ("ICC," specifically ICC(C,1) of McGraw & Wong [119]). The level of Krippendorff's alpha indicating agreement was 0.8, with values between 0.667 and 0.800 allowing for "tentative conclusions" [118]. For the ICC, values less than 0.40 were considered to be poor, between 0.40 and 0.60 were fair, between 0.60 and 0.75 were good, and greater than 0.75 were excellent [120]. The reliability values of Krippendorff's alpha obtained for the scale construction and scale evaluation data sets were 0.414 and 0.383, respectively. ICC values for the two data sets were 0.473 [95% CI: 0.359, 0.625] and 0.459 [95% CI: 0.346, 0.612], using only the ratings of speakers that were cross-tested in both countries.

5.3.5. Internal consistency

Lastly, the internal consistency of a scale measures the similarity of results across scale items. We examined this by calculating Cronbach's alpha [121] as well as three variations of the omega coefficient (Raykov, Bentler, and McDonald, as described in [122]). The criterion used for acceptable values of internal consistency measures, given that this study is basic research for the purpose of developing a scale, was 0.80 [80,123].

Using the fitted MLMVS model with adjustments from the complex survey design, internal consistency measures were well above the cutoff for the overall scale, and above or slightly below it for the three PRI latent factors (Table 7). Analyses showed that these values would only decrease we removed any individual scale item, suggesting that they are all vital to the structure of the scale.

Acknowledgments

We thank Russell Gray for his advisement of this project. We also thank Jerry Vaske and Jeffrey Snodgrass for their valuable feedback, Mark Prince for help with structural equation modelling methods, and Cory Holland for advice on speech recording and accent evaluation.

The recordings used in this project—except for American West (Urban) and Wales, recorded by the authors—are used by special permission of the International Dialects of English Archive, online at http://www.dialectsarchive.com, and we are grateful to IDEA for the licensed use of these recordings. *Comma Gets a Cure* is copyright 2000 Douglas N. Honorof, Jill McCullough & Barbara Somerville, text available online at: http://www.dialectsarchive.com/comma-gets-a-cure.

The colour palettes used in figures are derived from a technical note by Paul Tol (https://personal.sron.nl/~pault/) and are optimized for colour-blind readers.

Ethical Statement

We obtained written prior informed consent from all participants in this research. Participants that completed surveys through the Amazon Mechanical Turk and Prolific platforms were compensated above hourly minimum wage, in the state of Colorado for US participants and in the UK for participants located there, based upon the time needed to complete the surveys. Participants self-reported demographic information for socioculturally determined constructs such as ethnicity and gender, using categories in accordance with current local and ethical guidelines. Full details on these categories are given in the description of each data set in the supplementary material (**Metadata S3**).

Prior approval for research protocols was obtained from the Colorado State University Institutional Review Board (protocol #014-16H) and the University of Bristol Faculty of Arts Human Research Ethics Committee (protocols #26561, #31041, and #38323).

Funding Statement

This work was supported by a grant from the Max Planck Institute for the Science of Human History.

Data Accessibility

The datasets supporting this article have been uploaded as part of the supplementary material.

Competing Interests

We declare that we have no competing interests.

Authors' Contributions

All authors contributed to the conception and design of the study. REWB and ANS collected the data. REWB analysed and interpreted the data and drafted the initial manuscript. All authors revised the manuscript, gave final approval for publication, and agree to be accountable for all aspects of the work

Appendix C: Content bias definitions used for coding narratives in the transmission study and the FPPT

Content Bias	Definition
Social (Basic)	Interactions or relationships between individuals or groups
Social (Gossip)	Interactions or relationships between individuals or groups concerning third parties, or references to reputation or reputational costs, or the literal act of gossiping about other individuals
Survival	Explicit references to food, water, clothing, shelter, tools, predators, natural threats and disasters, seasonal cycles, reproduction, death, or disease in a survival context
Emotional (Positive)	Explicit displays or expressions of, or reference or reaction to, a positive emotional response beyond baseline, or an event that is expected to evoke a strong basic emotional response in the audience
Emotional (Negative)	Explicit displays or expressions of, or reference or reaction to, a negative emotional response beyond baseline, or an event that is expected to evoke a strong basic emotional response in the audience
Moral	Deals with social norms, taboos, and values, deviation from social norms, and rewards for adherence or punishment for deviance
Rational	Concerns cause-and-effect relationships or employing causal reasoning
Counterintuitive	Violations of ontological properties of folk-biology, folk-psychology or folk-physics

Appendix D: *Muki* and *Taka and Toro* stories

Muki

In the beginning times, Mata and Pata had run away together from the place of their people, far away beyond the realm of the sky, farther away than the stars stretch. The elder ones had not approved of their marriage and so they fled to our world here, which was then only a vast plain. They had with them their Child, Muki, who was the source of their greatest joys.

Here Mata rested with the sleeping Child at her breast, but the rest was short. Their people were hunting them and Muki would slow them when they most needed speed.

Pata took some black clay from his pack. Mata breathed upon the clay and shaped it with her hands, rolling it warm and round. Pata shaped it into a hammock with his hands, weaving its strands together, and hung it on the sky. Mata placed Muki carefully within the hammock, and pressed kisses to the Child's cheek. Then Mata plucked hairs from her own head, and hairs from Pata's chin, and scattered them across the ground. Pata struck his flint, which sent a bright, fiery spark up among the stars. The spark wandered about, bringing warmth and light to the world.

Mata and Pata swore to return one day for Muki. They whispered to her, "Sleep deeply, grow, and be loved."

When Muki woke from dreaming, wanting Mata's breast for her milk and Pata's steady hands for their comfort, they were no longer there. The Child beat her fists upon the earth until it quaked and shuddered. Muki cried and cried, until the spark in the sky darted away, leaving the Child and the world in darkness.

Muki grabbed fists full of clay and scraped out steep valleys in the land. The Child's tantrum churned up the hills as her kicking heels pounded in the earth. Her blood stained the clay, giving life, and she cried huge tears that became the Great River.

From the hairs of Mata's head, a forest of trees grew. The trees grew strong and tall and fruit of many colors sprouted from their branches.

On the shores of the Great River, the hairs of Pata's chin became spiders and crawled up from their bed of clay, moving on eight long, wiry legs. Muki snatched up a spider and pulled off each of its legs, one by one. The spider, wriggling from the pain, became a snake. Muki then tore the snake in two, dropping half into the water This half-snake was now the swimming Fish. Muki tried to eat the other half, but Snake bared its fangs full of venom and Muki spat it out with a retch.

When another spider crawled up, this time Muki tore off four of its legs. This spider grew large and became the strong Wolf, which bounded away into the trees.

"Do not go near the Child!" called the animals to the next spider who crawled up from the river. But this one was too clever to be caught. Six of its wiry legs

twisted around each other to form wings that began to flap. Soaring up above the forest, this spider became the clever Bird.

Then the last Spider summoned together the Snake, the Fish, the Wolf, and the Bird in the forest by the Great River. It was decided that the animals ought to live in different ways. Fish would have the winding river, Wolf would have the shadowed forests, and Snake would have the broad plains. Bird claimed the open skies for itself. "And I will have the hiding places," said Spider.

As they talked, Muki continued to shake the ground. Spider asked, "How will we stop the destruction of our homes?"

Bird said, "I flew high and fast, and I heard shouting voices in the sky. We should give the Child to these other people who search for her."

Snake disagreed, "We should not give the Child to those people, because they are not her people and seek to do her harm."

Wolf said, "Then we must be the Child's people, for it is right to look after children in need."

So Snake, Wolf, and Spider climbed across the Child's belly to tickle her until she laughed. Muki fell back onto the earth, happy and quiet.

Yet the world was still in darkness, as there was no light in the sky. Spider caught sight of the wandering spark in the sky and shouted, "You! You shall be the Sun for our world. When you light the skies and the land Muki will wake, and when you rest and the world darkens, Muki will sleep." The Sun shone proudly, for it is good to have purpose, and it brought the changing of the seasons.

Then out of the clay came our people, those who are our ancestors, because the land around Muki was good and fertile. The Child called Muki became the mountain that protects our village. We knew then as we do today that the Child must never be alone again, and we wait for Mata and Pata to return for her.

And when our people say today to our children, "Sleep deeply, grow, and be loved," we say it so that Muki hears this too and knows that she is not alone.

Text stats:887 words, 265 propositions, 7:01 estimated reading time, average reading level grade 6.20
Bias count:34 basic social, 11 gossip social, 22 survival, 9 positive emotional, 16 negative emotional, 9 moral, 7 distinct counterintuitive, 3 counterintuitive domains, 41 total counterintuitive, 20 rational

Taka and Toro

In the beginning times, Taka and her younger brother Toro were rowing through a storm and crashed upon a rocky island in the sea. Taka stepped ashore and the sharp rocks cut her feet. Everywhere her blood touched, life sprung forth. The grasses and the trees took root and the people, our ancestors, arose from the drops of blood.

Our ancestors learned from Taka and became her friends, and this made Toro feel jealous. She was always too busy playing with them.

"Oh-ho," cackled Puna, the bird in the palm, "Toro, who will you play with now?"

Toro was saddened by Puna's mocking words. He decided to make his own island. "It will be a new and BETTER island," Toro thought with a grin, "so then everyone will want to play with ME!"

Toro climbed up the palm and with his knife cut down the leaves. These he wove together, and bound with rope.

"Oh-ho," cackled Puna, "That is a raft, not an island, and you have not even performed the proper rites!"

But Toro was clever. He said, "If I promise to feed you and your family until your bellies are full, will you help me? If I give something to you, you must return the favor."

"Well," said Puna, "Our bellies are never full. But what is your plan?"

Placing his fingers in his mouth, Toro blew a whistle so piercing that Puna fell from her perch in terror. From out of the jungle came a mass of red ants.

"Why do you call us?" they demanded in their many tiny voices.

"I am building a new island," Toro announced, "And if you help me you can be the first to live there and can take the best homes for yourselves."

The ants agreed, and soon thousands of them came marching out of the jungle, carrying palm leaves on their backs. Toro continued to weave the leaves and the raft grew so large that it was bigger than Taka's island. The ants crawled up onto the raft.

Then, from the sky, dropped Puna and her family. When the birds were satisfied from feasting upon the ants, they grabbed hold of the edges of the new island and lifted it off of Taka's beach and into the sea. They pulled four times under the watch of the moon, and five under the watch of the sun, and they came to a place where the fish were many.

Toro swam down, down, and bound his island to the sea floor so it would not float away. Toro covered the island with soil and built up huge mountains from the land. The sea was pleased with Toro's new island and so sent coconuts to its shores. The coconuts sprouted into thick groves of palms. Toro was very proud. "My island is now the best of them all," he said to himself.

Yet still only Puna came, and that was to see whether there were more of the tasty ants. Toro was disappointed. He reached beneath the waves and found himself

a crab. Toro said to the crab, "You must carry news of this island to my sister's people."

The crab, whose name was Kawa, narrowed his beady eyes and spoke, "That is a long way, and I am too lazy to swim that far."

Puna flew down and ate Kawa, because the lazy are always punished for their carelessness. Puna then carried Kawa's shell, filled with Toro's whispers of the island, and dropped it onto Taka's beach. All across Taka's island, the people began to speak of the rumors.

Hoki told his wife Otta, "At the other island, there are so many fish there is no room for them all in the sea. They leap out of the water and into a man's arms like a woman. There are also many palms at the other island, and here there are more neighbours than trees. This is not as it should be."

Over the crashing of the waves, Otta did not hear her husband's words clearly. Otta went and told her sister Kohe, "My husband speaks of other women in his arms! He should not have broken my spirit in this way. If he wishes to go to the new place alone, I will not be sorry."

The people of Taka's island readied their boats together. When these people, our ancestors, came to Toro's island, the island that we call home, they saw that it was all that had been promised.

Taka was not happy that Toro had taken her playmates away. And so she sent the summer storms, making travel dangerous between our two homes. But Taka was an older sister, and like all older sisters, she loved her younger brother in spite of herself. And so she sent the winter trade winds which bring us prosperity and happiness.

We remember this, and today we praise the gods for our good fortune and celebrate.

Text stats:835 words, 273 propositions, 6:35 estimated reading time, average reading level grade 6.11
Bias count:33 basic social, 10 gossip social, 22 survival, 9 positive emotional, 15 negative emotional, 8 moral, 7 distinct counterintuitive, 3 counterintuitive domains, 20 total counterintuitive, 21 rational

Appendix E: Coding protocol for *Muki* and *Taka and Toro* stories

Muki

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
1	1	BEGINNING, TIMES		Give for any temporal clause; "creation myth" or "origin story" is not given	1									
1	2	RUN AWAY FROM, MATA, PATA, PLACE OF PEOPLE		Give if "run away" was mentioned	1									
1	4	TOGETHER, MATA, PATA		"Together" needed to be specified	1	1								
1	5	FAR AWAY, PLACE OF PEOPLE		Give if some aspect of distance is mentioned	1									
1	6	BEYOND, PLACE OF PEOPLE, REALM OF SKY		Give if there is mention of "sky"	1							P1		
1	7	FARTHER AWAY THAN, PLACE OF PEOPLE, STARS STRETCH		Give if there is mention of "stars"	1							P1		
2	8	NOT APPROVE OF, ELDER ONES, MARRIAGE		Give if anything demonstrating disapproval is present (i.e. were not happy, thought it was wrong) to show moral bias. Be lenient about elders, people, kin, etc.	1		1				1			
2	9	MARRIAGE, MATA, PATA		"Marriage" needs to be specified	1	1								

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
2	10	FLEE TO, MATA, PATA, WORLD		Give only if something to suggest a more harrowing experience (i.e. flee, escape) than running away. If run away mentioned again should not be given	1					1		P1		FEAR
2	10.5	OUR, WORLD			1									
2	10.6	HERE, WORLD			1									
2	11	SO, 8, 10			1								1	
2	12	PLAIN, WORLD		Give if they mention "plains"	1									
3	13	VAST, PLAIN			1									
3	14	WITH, MATA, PATA, MUKI		Give if it is specified that the child is with M/P directly, or interact with child in surrounding sentences.	1	1								
3	15	CHILD, MUKI, MATA, PATA		Give if statement focuses on kin/offspring relationship: e.g. "they had a child" or "daughter"	1	1								
3	16	SOURCE OF JOYS, MUKI, MATA, PATA			1				1					ENJOYMENT
3	17	GREATEST, JOYS			1									
4	18	REST, MATA			1									
4	19	WITH, MATA, CHILD			1	1								
4	20	AT BREAST, CHILD, MATA		Give if there is mention of child feeding	1									
4	21	SLEEP, CHILD		Give if reference to child sleeping at any point in the	1									

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
				pre-spider story. e.g. child is put in hammock to sleep										
4	22	SHORT, REST			1									
5	23	HUNT, PEOPLE, MATA, PATA		Give if some aspect of "chase" or "hunt"	1		1	1		1				ANGER(hunters)/FEAR(hunted)
5	24	SLOW, MUKI, MATA, PATA			1	1								
5	25	NEED MOST, MATA, PATA, SPEED			1									
5	25.5	WHEN, 24, 25			1									
6	26	TAKE, PATA, CLAY			1									
6	27	BLACK, CLAY			1									
6	28	FROM PACK, CLAY			1									
6	30	BREATHE ON, MATA, CLAY			1									
6	31	SHAPE, MATA, CLAY			1									
6	32	WITH, 31, HANDS			1									
6	33	ROLL, MATA, CLAY			1									
6	34	WARM, 33			1									
6	35	ROUND, 33			1									
8	37	SHAPE, PATA, CLAY, HAMMOCK		Give if the hammock is made or constructed in some way e.g. "they made a hammock"	1			1						
8	38	WITH, 37, HANDS			1									
8	40	WEAVE TOGETHER, PATA, STRANDS		Give only if "weaving" is indicated	1			1						
8	42	HANG, PATA, HAMMOCK, SKY		Allow if hammock is hung with stars, up high etc	1							P2		
9	43	PLACE, MATA, MUKI, HAMMOCK			1	1								

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
9	44	CAREFULLY, 43			1									
9	45	PRESS TO, MATA, CHILD, KISSES, CHEEK		Give if any mention of "kiss" or "cheek"	1	1			1					ENJOYMENT
10	47	PLUCK MATA, HAIRS			1									
10	48	FROM, MATA, HEAD, 47			1									
10	48.5	FROM, PATA, CHIN, 47		Give if "beard" is mentioned in this context	1	1								
10	49	SCATTER ACROSS, MATA, HAIRS, GROUND			1									
11	50	STRIKE, PATA, FLINT		Give only if "flint" is mentioned	1			1						
11	50.5	PATA, FLINT			1									
11	51	SEND UP, 51, SPARK		Give also if constructions refer to "sky" e.g. "sent into sky" "put into sky"	1								1	
11	51.5	AMONG, SPARK, STARS			1							P2		
11	51.6	BRIGHT, SPARK		Use this when "spark" is mentioned but no other context of spark	1									
11	51.7	FIERY, SPARK		Use this when "fire" is mentioned instead of spark	1									
11	52	WANDER ABOUT, SPARK			1							M1		
11	53	BRING TO, SPARK, WARMTH, WORLD		Give only if "warmth" mentioned	1									
11	54	BRING TO, SPARK, LIGHT, WORLD		Give only if "light" mentioned	1									
12	55	SWEAR TO RETURN, MATA, PATA			1									

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
12	56	FOR, 55, MUKI			1	1								
12	58	WHISPER, MATA, PATA, MUKI		Give if any kind of speech to Muki	1	1								
12	59	SLEEP, 58			1									
12	60	DEEPLY, SLEEP		Give this only when "deeply" is mentioned (as a narrative feature). If "sleep well" or "sleep tight" is used only proposition 59 should be given.	1									
12	61	GROW, 58			1									
12	62	BE LOVED, 58			1				1					ENJOYMENT
13	63	WAKE, MUKI			1									
13	63.5	FROM DREAMING, 63			1									
13	64	WANT, MUKI, MATA, BREAST		Give if "wanted" was mentioned e.g. "wanted her parents"	1									
13	65	FOR, 64, MILK		Give if anything to do with feeding is mentioned e.g. "hungry"	1			1					1	
13	66	WANT, MUKI, PATA, HANDS		Give if "wanted" was mentioned e.g. "wanted her parents"	1									
13	67	STEADY, HANDS			1									
13	68	FOR, 66, COMFORT			1									
13	69	ARE NO LONGER, MATA, PATA, THERE		Give for constructions such as "Mata and Pata had left", "Muki was left alone"	1									

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
13	70	WHEN, 63, 69		Give only if "when" is mentioned	1									
14	72	BEAT, CHILD, EARTH, FISTS			1					1				ANGER
14	73	QUAKE, EARTH			1									
14	74	SHUDDER, EARTH			1									
14	75	UNTIL, 72, 73, 74			1							B1	1	
15	76	CRY, MUKI		Use this proposition when responses mention Muki is sad/upset/angry on waking, but no other context.	1					1				SADNESS
15	78	DART AWAY, SPARK			1					1		M1		FEAR
15	79	UNTIL, 76, 77, 78			1								1	
15	80	LEAVE IN, SPARK, CHILD, DARKNESS		Give only if if "child" is left in darkness (or Muki)	1									
15	81	LEAVE IN, SPARK, WORLD, DARKNESS		Give only if if "world" is left in darkness (or land, world, etc)	1									
16	82	GRAB FISTS FULL OF, MUKI, CLAY			1									
16	83	SCRAPE, MUKI, LAND, VALLEYS		Give if responses mention creating "valleys" or other geographical features e.g. ravines	1							B1		
16	84	STEEP, VALLEYS			1									
17	85	CHURN UP, TANTRUM, HILLS		Given if they talk about creating "hills"/"mountains"	1							B1		
17	86	TANTRUM, CHILD		Given if they say that "the child /Muki had a tantrum"	1					1				ANGER

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
17	87	POUND IN, CHILD, HEELS, EARTH			1									
17	88	KICKING, HEELS			1									
18	89	STAIN, BLOOD, CLAY		Blood has to stain the clay/spill on the ground for this proposition to be given. If response only mentions blood, give proposition 90.	1									
18	90	BLOOD, MUKI			1					1				DISGUST
18	91	GIVE, 90, LIFE			1							B2		
18	92	CRY, MUKI, TEARS			1					1				SADNESS
18	93	HUGE, TEARS			1									
18	94	BECOME GREAT RIVER, TEARS			1							B1	1	
19	95	GROW, FOREST OF TREES		Give when response mentions "trees growing from hairs" or similar, even if it doesn't mention a forest. Don't code 97 as well unless "trees growing" is repeated in some form.	1									
19	96	FROM, HAIRS, MATA, HEAD, 95			1							B2	1	
20	97	GROW, TREES			1									
20	98	STRONG, TREES			1									
20	99	TALL, TREES			1									
20	100	SPROUT FROM, FRUIT, BRANCHES			1			1						

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
20	101	MANY COLOURS, FRUIT			1			1						"juicy"?
20	101.5	TREES, BRANCHES			1									
22	105	BECOME, HAIRS, SPIDERS			1							B2		
22	106	FROM, HAIRS, PATA, CHIN, 105			1								1	
22	107	ON SHORES OF, 106, GREAT RIVER			1									
22	108	CRAWL UP FROM, SPIDERS, BED OF CLAY			1									
22	109	MOVE, SPIDERS, LEGS			1									
22	110	EIGHT, LEGS			1									
22	111	LONG, LEGS			1									
22	112	WIRY, LEGS			1									
23	113	SNATCH UP, MUKI, SPIDER			1	1								
23	114	PULL OFF EACH OF, MUKI, SPIDER, LEGS		Given if "pulled off legs"	1	1				1				ANGER/SADNESS
23	115	ONE BY ONE, 114			1									
23	116	WRIGGLE, SPIDER			1									
23	116.5	FROM PAIN, 116			1					1			1	ANGER/SADNESS
23	117	BECOME, SPIDER, SNAKE		Give proposition of "becoming" in cases where spider becomes new animal OR legs become new animal.	1							B3		
24	118	TEAR, MUKI, SNAKE			1	1				1				ANGER/SADNESS
24	119	IN TWO, 118			1									
24	120	DROP, MUKI, HALF SNAKE			1	1								
24	121	INTO WATER, 120		Any body of water was allowed	1									

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
25	122	IS, HALF SNAKE, FISH		Give proposition of "becoming" in cases where spider becomes new animal OR legs become new animal. Give also if response mentions that spider became a fish, because the bias is preserved (animal transformation).	1							B3		
25	123	SWIMMING, FISH			1									
26	124	EAT, MUKI, HALF SNAKE			1	1		1						
26	124.5	TRY, MUKI, 124			1									
26	124.6	HALF SNAKE, OTHER			1									
26	125	BARE, SNAKE, FANGS			1			1		1				ANGER/FEAR
26	126	FULL OF, FANGS, VENOM		Given with any mention of "venom"/"poison"	1			1						
26	127	SPIT OUT, MUKI, SNAKE			1	1								
26	128	WITH, 127, RETCH			1					1				DISGUST
27	129	CRAWL, SPIDER, UP			1									
27	130	TEAR OFF, MUKI, SPIDER, LEGS			1	1				1				ANGER/SADNESS
27	131	FOUR, 130			1									
28	132	GROW, SPIDER			1									
28	133	LARGE, 132			1									
28	134	BECOME, SPIDER, WOLF		Give proposition of "becoming" in cases where spider becomes new animal OR legs become new animal.	1							B3		

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
				The animal has to be correct (i.e. no dog/fox)										
28	135	STRONG, WOLF			1									
28	135.5	BOUND AWAY, WOLF			1									
28	135.6	INTO, 135.5, TREES			1									
29	136	CALL, ANIMALS, SPIDER			1	1						M2		
29	137	NEXT, SPIDER		Give this when "another" or an ordinal term is given indicating the next spider	1									
29	138	NOT GO NEAR, SPIDER, CHILD, 136			1		1							
30	139	CLEVER, SPIDER			1							M2		
30	140	BECAUSE, NOT CAUGHT, 139			1								1	
31	141	TWIST AROUND, SPIDER, LEGS, LEGS			1									
31	142	SIX, LEGS			1									
31	143	WIRY, LEGS			1									
31	144	FORM, LEGS, WINGS, SPIDER			1							B3		
31	145	FLAP, WINGS			1									
32	146	SOAR ABOVE, SPIDER, FOREST		Use only for "flew into sky". If response only mentions flying, give proposition 175	1									
32	147	BECOME, SPIDER, BIRD		Give proposition of "becoming" in cases where spider becomes new animal OR legs become new animal.	1							B3		

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
32	148	CLEVER, BIRD			1							M2		
33	149	SUMMON, SPIDER, ANIMALS		Give when any particular animal is instrumental in bringing animals together (need not be spider)	1	1						M2		
33	150	TOGETHER, ANIMALS		Give when any form of organising together occurs, including a list of the animals together	1	1						M2		
33	153	LAST, SPIDER			1									
33	154	IN, 149, FOREST			1									
33	155	BY, 149, GREAT RIVER			1									
33	155.5	LIVE, WAYS, ANIMALS			1									
33	155.6	DIFFERENT, WAYS		Give for any mention of "different" or "own" / "lives" or "land" or "habitat"	1									
33	155.7	OUGHT TO, 155.5		There has to be some mention of "should"/"must" for the proposition to be awarded	1						1			
34	156	DECIDE, ANIMALS, 155.7			1	1						M2		
35	157	HAVE, FISH, RIVER		Any mention of water was given because some people originally described the river as "sea"/"ocean" and the story previously mentioned being dropped into "water"	1			1						
35	157.5	WINDING, RIVER			1									
35	158	HAVE, WOLF, FORESTS			1			1						

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
35	158.5	SHADOWED, FORESTS			1									
35	159	HAVE, SNAKE, PLAINS			1			1						
35	160	BROAD, PLAINS			1									
36	161	CLAIM, BIRD, SKIES		Give if response mentions "air" rather than "skies"	1			1				M2		
36	161.5	OPEN, SKIES			1									
36	161.6	FOR, 161, BIRD			1									
36	162	SAY, SPIDER			1	1						M2		
37	163	HAVE, SPIDER, PLACES, 162			1			1						
37	163.5	HIDING, PLACES		Give synonyms such as "dark corners"	1									
38	164	TALK, ANIMALS			1	1						M2		
38	164.5	SHAKE, MUKI, GROUND		If response mentions Muki's "tantrum" and it is the first mention give proposition 86 Otherwise give this only is ground is shaking.	1							B1		
38	165	CONTINUE, 164.5		Synonyms are accepted. e.g. "Still"	1									
38	166	AS, 163.5, 165			1									
39	170	ASK, SPIDER			1	1						M2		
39	171	DESTRUCTION, HOMES		Has to talk about homes/habitats/shelter/houses to be awarded	1					1				FEAR/SADNESS
39	172	ANIMALS, HOMES		Has to talk about homes/habitats/shelter/houses to be awarded	1			1						

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
39	173	HOW STOP, ANIMALS, 171, 170		Only use if animals discuss how to stop Muki. "what to do with Muki/the child" should not be given.	1									
40	174	SAY, BIRD		If character and statement are misattributed, give the proposition that mentions the character.	1	1						M2		
40	175	FLEW, BIRD, 174			1									
40	176	HIGH, FLEW			1									
40	177	FAST, FLEW			1									
40	178	HEAR, BIRD, VOICES, 174			1		1							
40	178.5	IN, VOICES, SKY			1							P1		
40	178.6	SHOUTING, VOICES			1									
41	179	GIVE, CHILD, PEOPLE, 174			1		1							
41	179.5	OTHER, PEOPLE			1									
41	179.6	OUGHT TO, 179			1						1			
41	180	SEARCH FOR, PEOPLE, CHILD			1		1							
42	181	DISAGREE, SNAKE		If character and statement are misattributed, give the proposition that mentions the character.	1	1						M2		
42	182	SHOULD NOT, 179			1						1			
42	183	ARE NOT, CHILD, PEOPLE			1		1							
43	184	SEEK TO HARM, PEOPLE, MUKI			1		1			1				ANGER(people)/FEAR(muki)/SADNESS(muki)
43	184.5	BECAUSE, 182, 183, 184,			1								1	

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
		181												
44	185	SAY, WOLF		If character and statement are misattributed, give the proposition that mentions the character.	1	1						M2		
44	186	BE PEOPLE OF, ANIMALS, CHILD, 185		If response mentions animals saying "we should take care of the child" or similar, give both propostions 186 and 187.5.	1		1							
44	186.5	MUST, 186		There has to be some mention of "should"/"must"/"ought to" for the proposition to be awarded	1						1			
44	187	IN NEED, CHILDREN			1									
44	187.5	LOOK AFTER, 187		If response mentions animals saying "we should take care of the child" or similar, give both propostions 186 and 187.5.	1									
44	188	RIGHT, 187.5			1						1			
44	189	FOR, 186.5, 188			1								1	
45	190	CLIMB ACROSS, SNAKE, WOLF, SPIDER, BELLY		Give for any animal or combination of the animals.	1	1								
45	191	CHILD, BELLY			1									
45	193	TICKLE, 190, 191, 192, CHILD			1	1								
45	196	LAUGH, CHILD			1				1					ENJOYMENT

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
45	198	UNTIL, 193, 197			1								1	
46	199	FALL BACK ONTO, MUKI, EARTH			1									
46	200	HAPPY, MUKI			1				1					ENJOYMENT
46	201	QUIET, MUKI			1									
38	167	IS IN, WORLD, DARKNESS			1									
38	168	STILL, 167			1									
38	169	IS NOT IN, LIGHT, SKY			1									
38	169.5	AS, 167, 169			1								1	
47	202	SEE IN, SPIDER, SPARK, SKY			1									
47	203	WANDERING, SPARK			1							M1		
47	204	SHOUT, SPIDER			1	1						M2		
48	205	BE, SPARK, SUN, 204			1									
48	205.5	FOR, 205, WORLD			1									
48	205.6	OUR, WORLD			1									
49	206	LIGHT, SUN, SKIES		Give only if resonse specifies "sky"	1									
49	207	LIGHT, SUN, LAND		Give only if resonse specifies "land" (or world / earth etc)	1									
49	208	WAKE, MUKI			1									
49	209	WHEN, 206, 207, 208			1			1					1	
49	210	REST, SUN			1							M1		
49	211	DARKEN, WORLD			1									
49	212	SLEEP, MUKI			1									
49	213	WHEN, 210, 211, 212			1			1					1	
50	214	SHINE, SUN			1									
50	214.5	PROUDLY, SHINE			1				1			M1		ENJOYMENT

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
50	215	HAVE, PURPOSE			1									
50	216	IS GOOD, 215			1				1		1			ENJOYMENT
50	217	BECAUSE, 215, 214			1								1	
50	218	CHANGE, SEASONS			1			1						
50	218.5	BRING, SUN, 218			1			1						
51	219	COME OUT OF, PEOPLE, CLAY			1							B2		
51	220	ANCESTORS, PEOPLE			1									
51	220.5	OUR, ANCESTORS			1	1								
51	220.6	AROUND, LAND, MUKI			1									
51	221	GOOD, 220.6			1				1					ENJOYMENT
51	222	FERTILE, 220.6		Give only if responses mention "fertile" in the context of land around Muki	1			1						
51	223	BECAUSE, 221, 222, 219			1								1	
52	224	BECOME, CHILD, MOUNTAIN		Collapse 224 and 224.5 to single proposition; only give 224	1							B2		
52	224.5	CALL, CHILD, MUKI			1									
52	225	PROTECT, MOUNTAIN, VILLAGE			1			1						
52	225.5	OUR, VILLAGE			1									
52	225.6	BE, CHILD, ALONE			1									
53	226	MUST NEVER AGAIN, 225.6			1						1			
53	227	KNOW THEN, US, 226			1									
53	228	KNOW TODAY, US, 226			1									
53	229	RETURN FOR, MATA,			1		1							

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
		CHILD												
53	230	RETURN FOR, PATA, CHILD			1		1							
53	231	WAIT, US, 229, 230			1									
54	233	SAY, PEOPLE, CHILDREN			1	1								
54	233.5	OUR, PEOPLE			1	1								
54	233.6	OUR, CHILDREN			1	1								
54	234	SLEEP, 233			1									
54	235	DEEPLY, SLEEP		Give only if "deeply" mentioned as is part of a set repeated phrase. If "sleep well" or "sleep tight", only give proposition 234.	1									
54	236	GROW, 233			1									
54	237	BE LOVED, 233			1				1					ENJOYMENT
54	238	HEAR, MUKI, 234, 236, 237			1							M1		
54	238.5	NOT ALONE, MUKI			1									
54	239	KNOW, 238.5, MUKI			1							M1		
54	239.5	BECAUSE, 239, 238			1								1	
54	240	SO, 233, 239			1						1		1	

Taka and Toro

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
1	1	BEGINNING, TIMES		Give if any temporal clause is mentioned, however, not if identifying origin/creation story	1									
1	2	ROW THROUGH, TAKA, TORO, STORM		Only give if "storm" is mentioned	1			1						
1	4	BROTHER, TORO, TAKA		Give if sibling relationship is specified	1	1								
1	4.5	YOUNGER, BROTHER		Also give if "older sister" is mentioned	1									
1	5	CRASH UPON, TAKA, TORO, ISLAND			1					1				FEAR/SURPRISE
1	6	ROCKY, ISLAND			1									
1	8	IN, ISLAND, SEA			1									
2	9	STEP ASHORE, TAKA			1									
2	10	CUT, FEET, ROCKS		Give only if the injury is explicitly mentioned	1					1				FEAR/SADNESS
2	11	SHARP, ROCKS			1									
2	12	TAKA, FEET			1									
2	14	TOUCH, BLOOD, EVERYWHERE			1									
2	15	TAKA, BLOOD			1					1				DISGUST
2	16	SPRING FORTH, LIFE		Give if mentions life being formed/growing	1									
2	17	WHERE, 14, 16			1							B1	1	
3	18	TAKE ROOT, GRASSES			1									

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
3	19	TAKE ROOT, TREES			1									
3	20	ARISE, PEOPLE			1									
3	20.6	FROM, 20, DROPS			1							B1		
3	20.6	BLOOD, DROPS			1					1				DISGUST
3	21	ANCESTORS, PEOPLE		Give if mentions "ancestors"	1									
3	22	OUR, ANCESTORS			1	1								
4	23	LEARN FROM, ANCESTORS, TAKA			1	1								
4	24	OUR, ANCESTORS			1	1								
4	25	BECOME FRIENDS, ANCESTORS, TAKA			1	1								
4	26	FEEL JEALOUS, TORO			1					1				SADNESS/ANGER
4	27	MAKE, 23, 25, 26			1								1	
4	28	PLAY WITH, TAKA, ANCESTORS			1									
4	29	IS ALWAYS WITH, TAKA, BUSY, 28			1									
4	30	TOO, BUSY			1									
6	36	CACKLE, PUNA			1	1						M1		
6	37	BIRD, PUNA			1									
6	38	IN PALM, PUNA			1									
7	39	PLAY WITH NOW, TORO, WHOM, 36			1		1							
8	40	SADDEN, TORO			1					1				SADNESS
8	41	WORDS, PUNA			1							M1		
8	42	MOCKING, WORDS		Give if "mocking" or 'making fun of' is mentioned	1					1				SADNESS
8	43	BY, 40, 41			1								1	

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
8	44	MAKE, TORO, ISLAND			1									
8	45	OWN, TORO, ISLAND			1									
8	46	DECIDE, TORO, 44			1									
9	48	THINK, TORO			1									
9	50	NEW, ISLAND, 48		Give if mentioned in different contexts (i.e. they refer to a new island in a different sentence)	1									
9	51	BETTER, ISLAND, 48			1									
9	52	PLAY, EVERYONE			1		1							
9	53	WANT WITH, 52, TORO			1									
9	54	SO, 50, 51, 53, 48			1								1	
9	55	WITH, 48, GRIN			1				1					ENJOYMENT
10	56	CLIMB UP, TORO, PALM		Give if detail about how to build a raft is mentioned. If "building a raft/island" is mentioned, give proposition 69 or 70 instead	1									
10	57	CUT WITH, TORO, LEAVES, KNIFE		Give if detail about how to build a raft is mentioned. If "building a raft/island" is mentioned, give proposition 69 or 70 instead	1			1						
11	64	WEAVE TOGETHER, TORO, LEAVES		Give if detail about how to build a raft is mentioned. If "building a raft/island" is mentioned, give proposition 69 or 70 instead	1			1						

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
11	65	BIND WITH, TORO, LEAVES, ROPE		Give if detail about how to build a raft is mentioned. If "building a raft/island" is mentioned, give proposition 69 or 70 instead	1			1						
12	67	CACKLE, PUNA			1	1						M1		
13	69	ARE, RAFT, LEAVES			1									
13	70	ARE NOT, ISLAND, LEAVES			1									
13	72	NOT PERFORM, TORO, RITES, 67			1						1			
13	74	PROPER, RITES			1						1			
14	75	CLEVER, TORO			1									
15	79	SAY, TORO			1									
15	80	FEED, TORO, PUNA			1	1		1						
15	81	FEED, TORO, FAMILY			1		1	1						
15	82	FAMILY, PUNA			1	1								
15	83	FULL, BELLIES			1									
15	84	PUNA, FAMILY, BELLIES			1									
15	86	UNTIL, 80, 81, 83			1								1	
15	87	PROMISE, TORO, PUNA, 86			1	1					1			
15	88	HELP, PUNA, TORO			1	1								
15	89	HELP, FAMILY, TORO		Give only if "family's" help is stated	1		1							
15	90	IF, 87, 88, 89, 79			1								1	
15	91	GIVE, TORO, PUNA, SOMETHING		Give proposition if participants are vague and allude to bribery of some	1	1								

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
				sort										
15	92	RETURN, PUNA, TORO, FAVOR			1	1								
15	93	MUST, 92			1						1			
15	94	IF, 91, 93, 79			1								1	
16	95	SAY, PUNA			1							M1		
16	96	NEVER FULL, BELLIES, 95			1									
16	97	PUNA, FAMILY, BELLIES			1									
16	99	IS, WHAT, PLAN, 95			1									
16	99.5	YOUR, PLAN			1									
17	105	PLACE, TORO, FINGERS, MOUTH			1									
17	105.5	TORO, FINGERS			1									
17	106	TORO, MOUTH			1									
17	107	BLOW, TORO, WHISTLE			1									
17	110	PIERCING, WHISTLE			1									
17	111	FALL FROM, PUNA, PERCH			1									
17	112	IN, 111, TERROR			1					1				FEAR/SURPRISE
17	113	BECAUSE, 109, 110, 112			1								1	
18	114	COME FROM, MASS, JUNGLE		Give if participant mentions both "ants" and "jungle" or "forest" or "trees"	1									
18	115	IS, MASS, ANTS		Give if participants only mention "ants"	1									
18	116	RED, ANTS			1									
19	121	WHY CALL, TORO, ANTS, 122		If participants demonstrate that Toro called the ants,	1	1								

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
				award this proposition.										
20	122	DEMAND, ANTS			1	1						M1		
20	123	IN, 122, VOICES			1									
20	124	MANY, VOICES			1									
20	125	TINY, VOICES			1									
21	126	ANNOUNCE, TORO			1	1								
21	127	BUILD, TORO, ISLAND, 126			1									
21	127.5	NEW, ISLAND		Give if mentioned in different contexts (i.e. they refer to a new island in a different sentence)	1									
21	128	HELP, ANTS, TORO			1	1								
21	129	LIVE FIRST, ANTS, ISLAND			1									
21	130	TAKE, HOMES, ANTS			1			1						
21	131	BEST, HOMES			1									
21	132	FOR, 130, ANTS			1									
21	133	IF, 128, 129, 132, 126			1								1	
22	134	AGREE, ANTS			1							M1		
22	135	COME MARCHING OUT OF, ANTS, JUNGLE			1									
22	136	THOUSANDS, ANTS			1									
22	138	CARRY, ANTS, LEAVES			1									
22	140	PALM, LEAVES			1									
22	141	ON, 138, BACKS			1									
22	142	ANTS, BACKS			1									
23	144	WEAVE, TORO, LEAVES			1			1						
23	145	CONTINUE, 144			1									

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
23	146	GROW, RAFT			1									
23	146.5	LARGE, RAFT			1									
23	147	IS BIGGER THAN, RAFT, ISLAND			1									
23	148	TAKA, ISLAND			1									
23	149	THAT, 146, 147			1									
24	151	CRAWL UP ONTO, ANTS, RAFT			1									
25	154	DROP FROM, PUNA, FAMILY, SKY			1					1				SURPRISE/FEAR
25	156	PUNA, FAMILY			1	1								
26	157	FEAST UPON, BIRDS, ANTS			1	1		1						
26	158	SATISFIED FROM, BIRDS, 157			1				1					ENJOYMENT
26	159	GRAB HOLD OF, BIRDS, EDGES			1									
26	160	ISLAND, EDGES			1									
26	161	NEW, ISLAND		Give if mentioned in different contexts (i.e. they refer to a new island in a different sentence)	1									
26	162	LIFT OFF OF, BIRDS, ISLAND, BEACH			1							P1		
26	163	TAKA, BEACH			1									
26	164	LIFT INTO, BIRDS, ISLAND, SEA		Do not give if participants mention sailing to the new island	1							P1		

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
26	166	WHEN, 158, 159, 162, 164			1									
27	167	PULL, BIRDS, ISLAND			1							P1		
27	168	FOUR TIMES, 167		Give if participant mentions "nights"	1									
27	170	UNDER WATCH OF, 167, MOON			1									
27	171	PULL, BIRDS, ISLAND			1							P1		
27	172	FIVE TIMES, 171			1									
27	174	UNDER WATCH OF, 171, SUN		Give if participant mentions "days"	1									
27	175	COME TO, ALL, PLACE			1									
27	177	ARE, FISH, MANY			1			1						
27	178	WHERE, 175, 177			1									
28	180	SWIM DOWN, TORO			1									
28	181	BIND TO, TORO, ISLAND, SEA FLOOR		Give if participant mentions anchoring	1			1				P1		
28	182	NOT FLOAT AWAY, ISLAND			1									
28	183	SO, 181, 182			1								1	
29	184	COVER WITH, TORO, ISLAND, SOIL			1									
29	185	BUILD FROM, TORO, MOUNTAINS, LAND			1							P2		
29	186	HUGE, MOUNTAINS			1									
29	187	IS PLEASED WITH, SEA, ISLAND			1				1			M2		ENJOYMENT
29	188	TORO, ISLAND		Give if mentioned in	1									

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
				different contexts (i.e. they refer to a Toro's island in a different sentence)										
29	188.5	NEW, ISLAND		Give if mentioned in different contexts (i.e. they refer to a new island in a different sentence)	1									
29	189	SEND TO, SEA, COCONUTS, SHORES		Give if coconuts are sent by something	1			1						
29	190	ISLAND, SHORES			1									
29	191	SO, 187, 189			1							M2	1	
29	193	SPROUT INTO, COCONUTS, GROVES		Give if coconuts grew into trees/ghosts	1			1						
29	193.5	THICK, GROVES			1									
29	194	PALMS, GROVES			1									
30	195	IS PROUD, TORO			1				1					ENJOYMENT
31	196	SAY TO, TORO, SELF			1									
31	196.5	IS NOW, ISLAND, 196			1									
31	197	BEST OF ALL, ISLAND, 196		Give if participant mentions the island is great	1									
32	198	COME, PUNA, ISLAND			1									
32	199	ONLY, 198		Do not give if nobody comes to the island	1									
32	200	ARE MORE, ANTS			1									
32	201	TASTY, ANTS			1			1						
32	202	SEE WHETHER, PUNA, 200			1									
32	203	TO, 198, 202			1								1	

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
33	204	DISAPPOINTED, TORO			1					1				SADNESS
33	205	REACH BENEATH, TORO, WAVES			1									
33	206	FIND FOR, TORO, CRAB, TORO			1	1								
34	208	SAY TO, TORO, CRAB			1	1								
34	209	CARRY TO, CRAB, NEWS, PEOPLE			1		1							
34	210	OF, NEWS, ISLAND			1									
34	211	THIS, ISLAND			1									
34	212	TAKA, PEOPLE			1									
34	213	MUST, 209		Do not give if participants mention asking. Give only if there is direct ordering or need expressed	1									
35	214	IS, CRAB, NAME, KAWA			1									
35	215	NARROW, KAWA, EYES			1									
35	216	BEADY, EYES			1									
35	217	SPEAK, KAWA			1	1						M1		
36	218	IS, WAY TO ISLAND, LONG			1									
36	219	SWIM, KAWA, 218			1									
36	220	IS TOO LAZY TO, KAWA, 219, 217			1									
37	221	FLY DOWN, PUNA			1									
37	222	EAT, PUNA, KAWA			1	1		1						
37	223	PUNISH FOR, LAZY, CARELESSNESS			1					1	1			ANGER/FEAR/SADNESS
37	224	ALWAYS, 223			1									

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
37	225	BECAUSE, 222, 224			1						1		1	
38	226	CARRY, PUNA, SHELL			1									
38	227	KAWA, SHELL			1									
38	228	FILLED WITH, SHELL, WHISPERS			1							P3		
38	229	OF, WHISPERS, ISLAND			1									
38	232	DROP ON, PUNA, SHELL, BEACH			1									
38	233	TAKA, BEACH			1									
39	234	BEGIN TO SPEAK OF, PEOPLE, RUMORS		Give if "rumours/news are heard"	1	1								
39	235	ACROSS, 234, ISLAND			1									
39	236	TAKA, ISLAND			1									
40	237	TELL, HOKI, OTTA			1	1								
40	238	WIFE, OTTA, HOKI		Give if familial relationship is specified	1	1								
40	239	ARE, FISH, SO MANY			1			1						
40	240	IN, FISH, SEA			1									
40	240.5	NO ROOM FOR, 240			1									
40	241	THAT, 239, 240.5			1								1	
40	242	AT, 241, ISLAND, 237			1									
40	243	OTHER, ISLAND		Give if mentioned in different contexts (i.e. they refer to an other island in a different sentence)	1									
41	244	LEAP OUT OF INTO, FISH, WATER, ARMS			1									
41	245	MAN, ARMS			1									

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
41	246	LIKE, 244, WOMAN, 237			1		1							
42	247	ARE AT, PALMS, ISLAND, 237			1			1						
42	249	MANY, PALMS			1									
42	250	OTHER, ISLAND		Give if mentioned in different contexts (i.e. they refer to an other island in a different sentence)	1									
42	251	ARE MORE THAN, HERE, NEIGHBORS, TREES			1									
42	252	IS NOT AS SHOULD BE, 251, 237			1						1			
43	253	NOT HEAR CLEARLY, OTTA, WORDS		Give if "misheard" or "misunderstood"	1									
43	254	HUSBAND, WORDS			1									
43	256	CRASH, WAVES			1									
43	257	OVER, 256, 253			1								1	
43	258	WENT TO, OTTA, KOHE			1	1								
43	259	TELL, OTTA, KOHE			1	1								
43	260	SISTER, KOHE, OTTA		Give if familial relationship is specified	1	1								
43	261	SPEAK OF IN, HUSBAND, WOMEN, ARMS, 259			1		1							
43	262	OTHER, WOMEN			1									
43	263	HUSBAND, ARMS			1									
44	265	BREAK IN, HUSBAND, SPIRIT, WAY			1					1				SADNESS
44	266	OTTA, SPIRIT			1									

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
44	267	THIS, WAY			1									
44	268	SHOULD NOT, 265, 259			1						1			
44	269	GO TO, HUSBAND, PLACE			1									
44	270	NEW, PLACE		Give if mentioned in different contexts (i.e. they refer to a new island in a different sentence)	1									
44	271	ALONE, 269			1									
44	272	WISH TO, 270			1									
44	273	NOT BE SORRY, OTTA		Give if Otta refers to not caring	1									
44	274	IF, 272, 273, 259			1								1	
45	275	READY, PEOPLE, BOATS			1			1						
45	275.5	TOGETHER, PEOPLE			1	1								
45	276	OF, ISLAND, PEOPLE			1									
45	277	TAKA, ISLAND			1									
45	278	PEOPLE, BOATS			1									
46	279	COME TO, PEOPLE, ISLAND			1									
46	280	ANCESTORS, PEOPLE		Give if mentions "ancestors"	1									
46	281	OUR, ANCESTORS			1	1								
46	282	TORO, ISLAND		Give only if mentioned in this context	1									
46	283	CALL, US, ISLAND, HOME			1									
46	284	IS ALL PROMISED, ISLAND			1									
46	285	SEE, PEOPLE, 284			1									
46	286	WHEN, 279, 285			1								1	
47	287	IS NOT HAPPY, TAKA		Give if negative emotion is	1					1				SADNESS

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
				demonstated (e.g. jealousy, sadness, anger, etc.)										
47	288	TAKE AWAY, TORO, PLAYMATES		Give only if there is an interaction between Toro and the playmates (i.e. Toro must take away playmates)	1		1							
47	289	TAKA, PLAYMATES		Give only if there is mention of "playmates" or "friends"	1									
47	290	THAT, 287, 288			1								1	
48	291	SEND, TAKA, STORMS			1					1		P4		ANGER/FEAR
48	292	SUMMER, STORMS			1			1						
48	293	IS DANGEROUS BETWEEN, TRAVEL, HOMES			1			1		1				FEAR
48	294	OUR, HOMES			1									
48	295	TWO, HOMES			1									
48	296	MAKE, 291, 293			1									
48	297	SO, 290, 291			1								1	
49	298	IS, TAKA, OLDER SISTER			1									
49	299	LOVE, TAKA, TORO			1	1			1					ENJOYMENT
49	300	YOUNGER BROTHER, TORO, TAKA			1	1								
49	301	IN SPITE OF, 299, TAKA			1									
49	302	LOVE, ALL OLDER SISTERS, YOUNGER BROTHERS			1		1		1					ENJOYMENT
49	303	LIKE, 302, 301			1									
49	304	BECAUSE, 298, 303		Give if any explanation is given	1								1	

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
50	305	SEND, TAKA, WINDS			1							P4		
50	306	WINTER, WINDS			1			1						
50	307	TRADE, WINDS			1									
50	308	BRING, WINDS, PROSPERITY			1			1						
50	309	BRING, WINDS, HAPPINESS			1				1					ENJOYMENT
50	310	WHICH, 305, 308, 309			1									
51	311	REMEMBER, US, 310			1									
51	312	PRAISE TODAY, US, GODS			1		1		1					ENJOYMENT
51	313	HAVE, US, FORTUNE			1									
51	314	GOOD, FORTUNE			1				1					ENJOYMENT
51	315	FOR, 312, 313			1								1	
51	316	CELEBRATE, US			1									

Appendix F: Examples of transcripts and excerpts of coded data for *Muki* and *Taka and Toro* stories recalled by participants

The extracted data in the coded sample appears in bold in the transcript.

Muki UK_1503179191995 High Prestige

Mata and Pata with their child Muki had to flee their land as the the compatriots did not approve of their marriage so they came to an, our land on a plain. But Mata and Pata were being chased by their own people and they were being slowed down by having to take their child Muki. So they decided to leave Muki and proceed on their own. They left Muki sleeping. When Muki awoke there was not the breast, the milk of her mother Mata or the comforting arm of her father Pata. And she threw a tantrum and cried and there her tears and blood brought both life. I must say that before Mata and Pata left Muki, Mata took some of her hair and threw it on the plain and Pa-Pa-Pata took some of his hair and threw in on the plain and Mata's hair, Mata's hair burst forth into a forest whereas Pata's hair, from Pata's hair came forth spiders. **The first spider, Muki removed all the legs from it one by one and this became a snake. Muki then tore the snake in two, threw one half into the water which became a fish and tried to eat the other half but the snake bared its fangs and she spat it out with a retch. Another spider turned into a wolf** and two other spiders talking to each other told them not to go near to the child. But the spider was clever and six of its legs entwined to become wings and that spider became a bird and another spider became a wolf. The animals then lived on different parts of this world. After some time Muki became a mountain that looks after the ancestors and they still wait for Mata and Pata to return and that is all I can remember of that story.

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
22	105	BECOME, HAIRS, SPIDERS	1		1							B2		
22	106	FROM, HAIRS, PATA, CHIN, 105	1		1								1	
22	107	ON SHORES OF, 106, GREAT RIVER			1									
22	108	CRAWL UP FROM, SPIDERS, BED			1									

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
		OF CLAY												
22	109	MOVE, SPIDERS, LEGS			1									
22	110	EIGHT, LEGS			1									
22	111	LONG, LEGS			1									
22	112	WIRY, LEGS			1									
23	113	SNATCH UP, MUKI, SPIDER			1	1								
23	114	PULL OFF EACH OF, MUKI, SPIDER, LEGS	1		1	1				1				ANGER/ SADNESS
23	115	ONE BY ONE, 114	1		1									
23	116	WRIGGLE, SPIDER			1									
23	116.5	FROM PAIN, 116			1					1			1	ANGER/ SADNESS
23	117	BECOME, SPIDER, SNAKE	1		1							B3		
24	118	TEAR, MUKI, SNAKE	1		1	1				1				ANGER/ SADNESS
24	119	IN TWO, 118	1		1									
24	120	DROP, MUKI, HALF SNAKE	1		1	1								
24	121	INTO WATER, 120	1		1									
25	122	IS, HALF SNAKE, FISH	1		1							B3		
25	123	SWIMMING, FISH			1									
26	124	EAT, MUKI, HALF SNAKE	1		1	1		1						
26	124.5	TRY, MUKI, 124	1		1									
26	124.6	HALF SNAKE, OTHER	1		1									
26	125	BARE, SNAKE, FANGS	1		1			1		1				ANGER/ FEAR
26	126	FULL OF, FANGS, VENOM			1			1						

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
26	127	SPIT OUT, MUKI, SNAKE	1		1	1								
26	128	WITH, 127, RETCH	1		1					1				DISGUST
27	129	CRAWL, SPIDER, UP			1									
27	130	TEAR OFF, MUKI, SPIDER, LEGS			1	1				1				ANGER/ SADNESS
27	131	FOUR, 130			1									
28	132	GROW, SPIDER			1									
28	133	LARGE, 132			1									
28	134	BECOME, SPIDER, WOLF	1		1							B3		
28	135	STRONG, WOLF			1									
28	135.5	BOUND AWAY, WOLF			1									
28	135.6	INTO, 135.5, TREES			1									

Taka and Toro USA_1503126188250 Low Prestige

Alright, so Taka and Toro and Taka had a special ability and with this ability it seemed like she made a lot of friends. And she had more friends than Toro. Toro had a jealous issue and was not happy that she had more friends. **So he says that he will go to an island and make his own island. And he went and he climbed up in a tree and he cut the leaves down and sews them all together. And when he's sewn them all together, he climbs out. His buddy told him that was a raft, not an island.** But they found him an island and he said it's gonna be the best island ever. (unclear) It didn't start out as planned so his friend had an idea. And he decided to, swam down to the very bottom of the water and I'm not sure what happened right there. I do know that Taka said that she loves Toro and she loves him very much and she was going to thank God for.

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
8	40	SADDEN, TORO								1				SADNESS
8	41	WORDS, PUNA										M1		
8	42	MOCKING, WORDS								1				SADNESS
8	43	BY, 40, 41											1	
8	44	MAKE, TORO, ISLAND	1											
8	45	OWN, TORO, ISLAND	1											
8	46	DECIDE, TORO, 44												
9	48	THINK, TORO												
9	50	NEW, ISLAND, 48												
9	51	BETTER, ISLAND, 48												
9	52	PLAY, EVERYONE					1							

line	proposition	text	Present	Coding notes	Prestige	Social (Basic)	Social (Gossip)	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Counterintuitive	Rational	Notes
9	53	WANT WITH, 52, TORO												
9	54	SO, 50, 51, 53, 48											1	
9	55	WITH, 48, GRIN							1					ENJOYMENT
10	56	CLIMB UP, TORO, PALM	1											
10	57	CUT WITH, TORO, LEAVES, KNIFE	1					1						
11	64	WEAVE TOGETHER, TORO, LEAVES	1					1						
11	65	BIND WITH, TORO, LEAVES, ROPE						1						
12	67	CACKLE, PUNA	1			1						M1		
13	69	ARE, RAFT, LEAVES	1											
13	70	ARE NOT, ISLAND, LEAVES	1											
13	72	NOT PERFORM, TORO, RITES, 67									1			
13	74	PROPER, RITES									1			

Appendix G: Full set of candidate generalised linear mixed models tested

A plus sign indicates that a variable was included in the specified model. Random effects of participant and proposition number were included in all models.

Number	Name	story	first story	line	line^2	prestige	social	survival	emotional positive	emotional negative	moral	rational	counterintuitive domain	country	gender	ethnicity	childhood town size	childhood town low prestige	education	occupation	income	memory
1	Null																					
2	Full	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
3	Story effects	+	+	+	+																	
4	Story	+																				
5	First story		+																			
6	Line number			+																		
7	Quadratic line number			+	+																	
8	Biases					+	+	+	+	+	+	+	+									
9	Prestige					+																
10	Content						+	+	+	+	+	+	+									
11	Social						+															
12	Survival							+														
13	Emotional								+	+												
14	Emotional (positive)								+													
15	Emotional (negative)									+												
16	Moral										+											
17	Rational											+										
18	Counterintuitive												+									
19	Demographics													+	+	+	+	+	+	+	+	+
20	Country													+								
21	Gender														+							

Number	Name	story	first story	line	line^2	prestige	social	survival	emotional positive	emotional negative	moral	rational	counterintuitive domain	country	gender	ethnicity	childhood town size	childhood town low prestige	education	occupation	income	memory
22	Ethnicity															+						
23	Town size																+					
24	Town low prestige																	+				
25	Education																		+			
26	Occupation																			+		
27	Income																				+	
28	Memory																					+
29	Story effects and biases	+	+	+	+	+	+	+	+	+	+	+	+									
30	Story effects and demographics	+	+	+	+									+	+	+	+	+	+	+	+	+
31	Biases and demographics					+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
32	Significant variables from full model		+			+	+	+		+			+								+	+
33	Significant variables from full model without income (“A”)		+			+	+	+		+			+									+
34	A with story	+	+			+	+	+		+			+									+
35	A with line number		+	+		+	+	+		+			+									+
36	A with quadratic line number		+	+	+	+	+	+		+			+									+
37	A with positive emotional		+			+	+	+	+	+			+									+
38	A with moral		+			+	+	+		+	+		+									+
39	A with rational		+			+	+	+		+		+	+									+
40	A with country		+			+	+	+		+			+	+								+
41	A with gender (“B”)		+			+	+	+		+			+		+							+
42	A with ethnicity		+			+	+	+		+			+			+						+
43	A with town size		+			+	+	+		+			+				+					+
44	A with town low prestige		+			+	+	+		+			+					+				+
45	A with education		+			+	+	+		+			+						+			+
46	A with occupation		+			+	+	+		+			+							+		+

Number	Name	story	first story	line	line^2	prestige	social	survival	emotional positive	emotional negative	moral	rational	counterintuitive domain	country	gender	ethnicity	childhood town size	childhood town low prestige	education	occupation	income	memory
47	B with story	+	+			+	+	+		+			+		+							+
48	B with line number		+	+		+	+	+		+			+		+							+
49	B with quadratic line number		+	+	+	+	+	+		+			+		+							+
50	B with positive emotional		+			+	+	+	+	+			+		+							+
51	B with moral		+			+	+	+		+	+		+		+							+
52	B with rational		+			+	+	+		+		+	+		+							+
53	B with country		+			+	+	+		+			+	+	+							+
54	B with ethnicity		+			+	+	+		+			+		+	+						+
55	B with town size		+			+	+	+		+			+		+		+					+
56	B with town low prestige		+			+	+	+		+			+		+			+				+
57	B with education		+			+	+	+		+			+		+				+			+
58	B with occupation		+			+	+	+		+			+		+					+		+

Appendix H: Three-way table of biases present in artificial story propositions

The first row within each bias gives the number of propositions (and percentage of the total) presented to each participant across both stories (N = 537 propositions), while the second row within each bias gives the number (and percentage) of propositions recalled across all participants (N = 12,492 propositions). Columns indicate an additional type of bias present in the same proposition, such that numbers on the diagonal (e.g. Social-Social) represent propositions with only the single indicated bias, while off-diagonals (e.g. Social-Moral) represent propositions that contained both indicated biases. Only one proposition in the original stories (at 0.2% of the total) contained three biases (Social, Survival, and Negative Emotional) and this proposition was recalled 51 times (0.4%). This proposition is not depicted in the table above but was included in analyses and the calculated percentages reflect its inclusion. The last two rows and column indicate unbiased propositions, or those that did not contain any of the content biases examined.

		Social	Survival	Emotional (Positive)	Emotional (Negative)	Moral	Rational	Counter-intuitive	Unbiased
Social	Presented	58 (10.8%)	5 (0.9%)	4 (0.7%)	4 (0.7%)	2 (0.4%)		14 (2.6%)	
	Recalled	1841 (14.7%)	269 (2.2%)	85 (0.7%)	246 (2.0%)	70 (0.6%)		269 (2.2%)	
Survival	Presented		31 (5.8%)		2 (0.4%)		3 (0.6%)	2 (0.4%)	
	Recalled		715 (5.7%)		42 (0.3%)		80 (0.6%)	102 (0.8%)	
Emotional (Positive)	Presented			11 (2.0%)		1 (0.2%)		2 (0.4%)	
	Recalled			119 (1.0%)		4 (< 0.1%)		41 (0.3 %)	
Emotional (Negative)	Presented				18 (3.4%)	1 (0.2%)	1 (0.2%)	3 (0.6%)	
	Recalled				788 (6.3%)	20 (0.2%)	6 (< 0.1%)	130 (1.0%)	
Moral	Presented					11 (2.0%)	2 (0.4%)		
	Recalled					118 (0.9%)	38 (0.3%)		
Rational	Presented						30 (5.6%)	5 (0.9%)	
	Recalled						521 (4.2%)	184 (1.5%)	
Counter-intuitive	Presented							35 (6.5%)	
	Recalled							1123 (9.0%)	
Unbiased	Presented								291 (54.2%)
	Recalled								5630 (45.1%)

Appendix I: Participant Information Sheet for the Family Problems Picture Task

Participant Information Sheet

Project title: Social Issues Picture Task

Invitation to participate in research
We would like to invite you to take part in our research project. Before you decide whether to participate, we would like you to understand why the research is being conducted and what it would involve. Please ask us questions if anything is unclear (see below for contact details).

What is the purpose of the project?

- This research forms part of an anthropology project looking at how we construct narratives.
- We are interested in the types of content we include in stories and how we create stories individually and in groups.
- This task has been carried out with speakers of Awiakay, Duna (Yuna), Iwaidja, Japanese, Ku Waru, Lamjung Yolmo, and Ngarinyin to elicit vernacular speech.
- We now want to carry out a similar study with English speakers.

Why have I been invited to participate?
You have been invited to participate in this project because you are an English speaker over the age of 18 years. We have attempted to recruit participants from different subjects and pair you with someone from another discipline.

Do I have to take part?
It is up to you to decide whether you wish to participate in the project. We invite you to read this information sheet before you participate and to ask any questions you might have. If you agree to take part, we will then ask you to sign a consent form. Participation in this research will have no affect on your programme of study and does not provide course credit. You are free to withdraw at any time, without giving a reason.

What will happen to me if I take part and what will I have to do?
If you agree to take part, we will arrange a time, date, and location for you to access the study. This research takes place in three stages. The first two stages will take place on campus and will take no longer than an hour. The third stage (20 minutes) is optional and can be accessed remotely online.
Stage 1: You will be presented individually with 16 line drawings using a web application. These images can be put in any order. You will be asked to order these images and to create a story based on the line drawings, which will be type up. You'll also be asked a few questions about your story.
Stage 2: Immediately after Stage 1, you will be paired up with another participant and presented with more line drawings. Together, you will be asked to order them and create a single story based on these pictures. You will then be asked to tell this story together. The creation of your shared story will be video-recorded, and later transcribed for analysis. Finally, you will be asked some questions about the story you have co-created to provide some basic demographic/contact details using the web application.
Stage 3 (Optional): You will be invited by email to create another story using images using the same interface as Stage 1. This stage is optional but we hope that you take part.

What are the possible disadvantages and risks involved in taking part in the project?
Some of the line drawings may be potentially distressing. Should you feel uncomfortable at any point you are welcome to withdraw from the study immediately. If necessary we can provide information about accessing counselling services.

What are the possible benefits of taking part?

This research will benefit the research community and advance our knowledge about the transmission of information through storytelling and how we negotiate group decision-making processes. There are no direct benefits for the participants, however.

Will my participation in this project be kept confidential?

- There are two types of "primary" data we are collecting for this project: the video recording of the creation of your group narrative; and a small amount of personal data (age; email address to invite you to Stage 3 of the study). The video recording will be transcribed, which means we write down everything that is said and done in the video. This transcript is a kind of "secondary" data.
- All recordings will be stored on the University of Bristol Research Data Storage Facility server.
- We will anonymise the data. This means we will use an alphanumeric ID in records of the data itself and in any reports based on the data. We will also pixelate faces in any shared in publications or presentations, unless you give permission for your face to remain without pixelation.
- The people who will have access to the raw video recordings (without pixelated faces) are: Alarna Samarasinghe, Professor Fiona Jordan, and other collaborators within the Department of Anthropology and Archaeology (but no one else).
- Short clips (less than a minute long) of the video recordings may be used in research presentations. You can opt to have your face pixelated.
- In the interests of keeping research transparent and replicable, we would like to keep the data for the next twenty years. However, should you wish to withdraw from the project, you can email Alarna Samarasinghe (details below) citing your alphanumeric ID and all associated primary data will be deleted.

What will happen to the results of the research project?

This research is an exploratory study and forms part of a thesis. The results of this study will be published as a chapter in a PhD thesis and potentially a scholarly journal article. As this research also informs a body of cross-cultural research on vernacular speech, other researchers outside of the Department of Anthropology and Archaeology and publication venues (i.e. journals) may be given access to transcripts of the stories you create, however, no identifying information or raw data will be shared.

Who is organising and funding the research?

The person who is organising this research study is Alarna Samarasinghe, a PhD student in the Department of Anthropology & Archaeology at the University of Bristol. The study is supervised by Professor Fiona Jordan in the same department.
This research is funded by the Max Planck Institute: Science of Human History.

Who has reviewed the study?

The Faculty of Arts Research Ethics Committee at the University of Bristol has reviewed this study.

For further information, please contact:

Alarna Samarasinghe
as15936@bristol.ac.uk

or

Professor Fiona Jordan
fiona.jordan@bristol.ac.uk

If you have any concerns related to your participation in this study please direct them to the Faculty of Arts Research Ethics Committee, via Liam McKervey, Research Governance and Ethics Officer (Tel: 0117 331 7472 email: Liam.McKervey@bristol.ac.uk)

Appendix J: Consent Form for the Family Problems Picture Task

Below are screenshots taken of the consent form. The consent form was delivered online through the web application.

Social issues picture task

You are invited to take part in study regarding how we construct narratives.

ParticipantID = YL58

This study is carried out in 3 parts, 2 of which will take place today, and the final part will take place in a week. We will ask you to leave your email address so that we can invite you to the final part of the study.

In the first part you will be shown some line drawings and asked to create a narrative. You will then be asked some questions about the narrative you've created. This part of the study will be completed online and take approximately 20 minutes.

You will then be asked to take part in a face-to-face study where you will create a narrative with another participant. This part of the study will be video recorded. We will then ask you to answer some questions on the online platform. This part of the study should take no longer than 40 minutes.

In one week's time you will be invited to participate in the final part of the study via email. This part of the study will be carried out online and you can complete at home from any desktop or laptop computer. In this part you will be shown some line drawings and asked to create a narrative. This should take approximately 20 minutes. After submitting this part of the study, your email address will be removed from our records.

Apart from your email address in the intial parts of the study and your voice and image in the video recording, no identifying information will be recorded. Your email address will be deleted on completion of the study and you can opt to have your face pixelated in any dissemination of recordings. Your data will be stored on encrypted, password-protected hard drives.

There are no physical risk in taking part in this study, other than those associated with everyday life. Some of the line drawings depict moderate violence and may cause mild distress.

You can withdraw from the study at any point without giving any reason. Should you wish to withdraw from the study, please contact Alarna Samarasinghe (details above). You will be provided with a 4-digit ID number that you can quote and all associated files will be deleted.

The research is carried out by Alarna Samarasinghe, a Postgraduate Researcher in the Department of Anthropology & Archaeology at the University of Bristol, and overseen by Professor Fiona Jordan and Dr Sean Roberts in the same department. If you have any questions, please contact Alarna Samarasinghe (as15936@bristol.ac.uk).

The Faculty of Arts Research Ethics Committee at the University of Bristol has reviewed this study.

If you have any concerns related to your participation in this study please direct them to the Faculty of Arts Research Ethics Committee, via Liam McKervey, Research Governance and Ethics Officer (Tel: 0117 331 7472 email: Liam.McKervey@bristol.ac.uk)

1. * I have received information about the study

- ◯ Yes
- ◯ No

2. * I understand that I am free to withdraw from this study without having to give a reason at any time

- ◯ Yes
- ◯ No

3. * I consent to having video recorded of me

- ◯ Yes
- ◯ No

4. * I consent to having video recorded of me disseminated for research or publication purposes

- ◯ Yes
- ◯ No

5. * I consent to having video recorded of me disseminated without pixelation of my face

- ◯ Yes
- ◯ No

6. * I consent to take part in this study

- ◯ Yes
- ◯ No

Complete

Appendix K: Example of the stories created in the Family Problems Picture Task

On the next pages are examples of the stories created in all phases of the FPPT for an individual. The images and text are in the order that the participants created and so the story can be read down each column. The first column refers to the story created in the first phase, where participants put images in order and wrote their story using the online platform. The second column refers to the story co-created by the individual in their dyad (second phase). This story was audio- and video- recorded as transcribed. I entered the transcribed data and story order into the online platform. The third column refers to the stories created by the individual in the third phase. Participants used the online platform to write this story one week after the first and second phases. At each phase participants were asked to choose which scene they thought was the most important using the online platform.

MG25

MG25

Phase1 most important Scene: 7 (S12.jpg)
Reason: This is the moment when everyone's life changes for ever.
Phase2 most important Scene: 7 (S12.jpg)
Reason: The moment when he hits her
Phase3 most important Scene: 7 (S12.jpg)
Reason: this is the moment where everything changes

N	phase1	X7	phase2	descriptions2	phase3	descriptions3
1		A husband and wife are out gathering food for themselves and their family. It's a sunny day, and all is well with the world.		So we begin with a man who is very happy in his life. He has, you know, a family.		They're out, gathering food, having a nice day
2		Their tasks complete, they walk home. The wife is holding the hand of their tiny child as they talk about the day, and their plans for the week ahead.		He works on a field with his wife and they're all happy together.		All is well as they walk home, their tiny child skipping along next to them
3		Later, the husband is out drinking with his friends. They're a bad lot, and his wife disapproves, but she knows he gets angry if she asks him not to go out. She waits at home, hoping he doesn't get too drunk this time.		He has two sons, a small son and an older son and when they come back together he is reminded by somebody who he passed on the way back from the field about the story, about his brother who's in prison.		Work for the day done, he goes drinking with his friends, leaving her at home to care for their child.

4

The husband's friend tells the husband that he's seen his wife talking to another man in the market. He tells him he saw her flirting, and that he should be a man and do something about it. The husband gets jealous and angry. The whole gang whips him up.

And he starts to begin to tell the story that he uses as a moral compass.

One of his friends decides to wind him up by telling him he's seen his wife flirting with a guy at the market

5

Furious, the husband stands up and says he's going to confront her with her infidelity. His friends laugh and joke, telling him to stay and have more beer with them, but he heads o↵ towards his home, his face twisted with anger.

So the story of the brother is he tried to live a moral life, an upright life and he tried to stay away from bad influences and said, 'No' when his friend tempted him with, you know, drinking midday.

His anger gets the better of him 'I'm going to have it out with her' he says

6

He confronts his wife with what he's been told. Scared, she tries to defend herself. 'I was only buying food from him' she says, nothing more than that. He raises his fist as she cowers, trying to protect her child.

Eventually he gave in and he started drinking with them and they, and his friends tried to break his relationship. So his friend told him that this guy's wife flirted with him.

Angry, drunk, he accuses his wife of flirting with the shopkeeper, telling her she was seen. She protests, explaining that she was just buying groceries as normal

7		Unable to contain his rage anymore, the husband punches his wife hard in the face. She cries out and drops the child. An old man passing by sees this happen and rushes to tell the police.		He got upset, went back to his wife, asked her if it was correct. She denies it.		Enraged, he hits her. She drops their child as she cries out. An old man sees the punch and calls the police
8		While the wife tries her best to comfort her baby, and tend to her own bleeding face, police drag the man away. He realises he's let his anger get the better of him, and tries to talk to his wife - but she is cold, turned away from him.		He beats her up.		The police come and lead the man away while his wife tends to her bleeding face and comforts her child
9		A trial is convened, and a local magistrate hears the wife's story. The husband is ashamed, and offers no defence.		She is beat up, crying, trying to protect her little baby. He's being carried away by law enforcement.		A day or so later, the man is up in front of the local magistrate. He's ashamed as he hears his wife describe what he did

10			
	He knows he's done wrong, but is scared of what will happen to him as he is convicted and sent to prison. His whole life has changed in this one moment, and he's devastated.	She is giving testimony on what happened	He realises he's going to prison, and is scared about what that will be like
11			
	Prison is worse than he imagined. No one beats him, but he's alone and hungry, and scared. he has nothing but his guilt and shame , and the flies in his stinking cell, to keep him company.	and he is sitting there thinking, 'Gosh, what did I do with my life? I'm gonna end up languishing my whole life in prison.'	it's so much worse than he imagined
12			
	Sometimes he dreams about what his life will be like when he's released. He thinks about his c	Indeed, that's what happens sadly. He gets thrown into prison and he has plenty of time to think of what he did.	while he's locked away, he thinks about what it's going to be like to go home, and dreams about a happy wife and son, both pleased to see him

13

And then, one day, a little bit further on in the future, he comes back home and sees his family. He's going back home and realise, and seeing his family a bit miserable and a bit grumpy about their life. And he's reminded, you know, think about my brother and what he's thinking of. So this is me being the other brother now. Going back, so, and he,

eventually he's released, and given new clothes by the prison.

14

and he is saying: 'Look, my brother is sitting in prison and all he can hope for is this kind of freedom where he comes home and his family greets me. And look, we have this freedom and we're not even happy. And all he's just sitting there and

he breathes his first breath of air as a free man. he's not the same man he used to be

15

he's just hoping that one day he gets free but it never comes so he's just stuck there. So we should be happy with what we have.'

he goes home, and is happy to see his family. They treat him with suspicion. He knows he cannot be with them any more

16			And, going back to the original storyline, original timeline. He's, the brother continues to tell his story to his friends, to everybody he's with to kind of keep them on like a moral kind of line, I guess. Yeah. Kind of remind them, you know, enjoy your freedom and don't do bad things.		Still, they sit with him and he tells them what his experiences in prison were like. Then he leaves them and goes to start a new life for himself.

ML53

1 ML53

2019-3-20 17:4:47
Phase1 most important Scene: 11 (S12.jpg)
Reason: This scene is the most important because the man's actions have a large number of implications, which are depicted in the other scenes, including other people gossiping about him assaulting the woman and also him being taken away by the police and sentenced to prison

Phase2 most important Scene: 6 (S4.jpg)
Reason: The scene of the brother giving in to temptation and drinking with his bad friends. That leads downhill and ends him up in prison.

Phase3 most important Scene: 9 (S10.jpg)
Reason: I think this scene really illustrates how selfish the character of Pierre is. He only thinks of himself and the consequences that he is going to face, instead of feeling sorry for what he has inflicted upon his family. He thinks of how he is going to be physically abused, with little regard for the physical abuse that he subjected his wife and young child to.

N	phase1	X22	phase2	descriptions2	phase3	descriptions3
1		A man goes outside and notices that it is a lovely day and the sun is shining		So we begin with a man who is very happy in his life. He has, you know, a family.		A man, Pierre, and his wife, Veronique, are collecting some root vegetables with their son, Pascal.
2		Given the lovely weather, his friends are outside enjoying the sun and invite him to have a drink with them. The man refuses because he does not drink because his brother was put in jail after his drunken behaviour. The man thinks about his brother's actions on his walk home		He works on a field with his wife and they're all happy together.		Pierre and Veronique enjoy this kind of work because it means they get to spend lots of time outside in the fresh air and it means they are able to spend their days with their son too.
3		The man gets home and decides to discuss his brother with his family		He has two sons, a small son and an older son and when they come back together he is reminded by somebody who he passed on the way back from the field about the story, about his brother who's in prison.		Later on that evening Pierre is having a drink with his friends and winding down after a hard day of work in the sun.

4 

The man recounts to his wife and child the conditions that his brother is currently living in in prison and how awful it must be for him

And he starts to begin to tell the story that he uses as a moral compass.

During this get-together, one of Pierre's friends mentions a rumour that his wife was flirting with a shop-keeper. This news makes Pierre very angry, as he does not question to information and assumes it to be true.

5 

At the same time, the man's brother (named David) sits in his cell in prison

So the story of the brother is he tried to live a moral life, an upright life and he tried to stay away from bad influences and said, 'No' when his friend tempted him with, you know, drinking midday.

Having heard the news, Pierre confronts his wife about the alleged affair. Veronique is scared by how angry Pierre seems and assures him that no flirting or affair took place. Instead, she says that the only interaction she has had with the shop-keeper is when she was paying for something she bought in his shop the other day.

6 

David thinks about his life behind bars and the abuse that he has suffered here as a result of his drunken actions that one time

Eventually he gave in and he started drinking with them and they, and his friends tried to break his relationship. So his friend told him that this guy's wife flirted with him.

Pierre does not believe Veronique and, in a drunken fit of rage, he assaults his wife. Veronique is holding Pascal at the time.

7		David thinks about what his brother must be doing at home right now and how much he wishes he could be with his family instead of alone in his prison cell		He got upset, went back to his wife, asked her if it was correct. She denies it.		Both Veronique and Pascal are badly injured from Pierre's assault and policemen are called to take Pierre away from the scene of the crime.
8		David thinks about the gossip about his wife that led him to drink. His friends told him gossip that his wife was being flirtatious with another man		He beats her up.		Later on, Veronique is called to give a testimony of the events that took place. She relays the series of events to the policemen and investigators. Pierre holds his heads in his hands whilst listening to his beloved wife relay his horrendous actions that evening.
9		Davis thinks about the day that he confronted his wife about her infidelity. David had been drinking and got into a discussion with his wife about her a↵air		She is beat up, crying, trying to protect her little baby. He's being carried away by law enforcement.		Pierre fears that his wife's testimony means he will end up in prison. Selfishly, he thinks about how ill-treated he could potentially be behind bars. He imagines himself being beaten by prison guards and it is apparent he does not feel guilty about what he did to his wife and young child, he is simply self-centred.

10		David became aggressive towards his wife as she denied the a↵air to him		She is giving testimony on what happened		Veronique's testimony lands Pierre is prison and he struggles with the anxieties of prison life, one of the most notable e↵ects if that he eats very little food.
11		He then physically assaulted his wife in front of their young child		and he is sitting there thinking, 'Gosh, what did I do with my life? I'm gonna end up languishing my whole life in prison.'		Pierre daydreams of how he will be lovingly greeted by his son and wife when he gets out of the joint.
12		David was then taken away by the police		Indeed, that's what happens sadly. He gets thrown into prison and he has plenty of time to think of what he did.		On the day that Pierre leaves prison he is given a fresh set of clothes for his release to replace the tattered clothing that he has been wearing since he was locked up.

13 

He thought of how gossip of his actions would have spread through their village and everyone would be talking about it

And then, one day, a little bit further on in the future, he comes back home and sees his family. He's going back home and realise, and seeing his family a bit miserable and a bit grumpy about their life. And he's reminded, you know, think about my brother and what he's thinking of. So this is me being the other brother now. Going back, so, and he,

Pierre enjoys the fresh air and sun and is smug with his new sense of freedom.

14 

Today David completes his last bit of community service and after this he is free to leave prison for good

and he is saying: 'Look, my brother is sitting in prison and all he can hope for is this kind of freedom where he comes home and his family greets me. And look, we have this freedom and we're not even happy. And all he's just sitting there and

Pierre walks past his old drinking buddies and refuses to engage in the old activities he used to enjoy with them, little does he know his son is spying on him.

15 

David collects his belonging from the police officer

he's just hoping that one day he gets free but it never comes so he's just stuck there. So we should be happy with what we have.'

Pierre makes it home and, much to his surprise, is not greeted lovingly by his family. Instead they look rather somber and unhappy that he is back.

16		David makes it home in time to enjoy a drink with his friends in the sunshine. Being sentenced to prison has not stopped him drinking		And, going back to the original storyline, original timeline. He's, the brother continues to tell his story to his friends, to everybody he's with to kind of keep them on like a moral kind of line, I guess. Yeah. Kind of remind them, you know, enjoy your freedom and don't do bad things.	 To win back his family's love, Pierre explains to them the horrible ordeal of prison and how he has changed.

Appendix L: Example transcripts of the stories created in the Family Problems Picture Task

AA42/MG46 Transcript

MG46: That camera's very close. (Man's perspective) I want to tell you how I've changed. We used to be so happy together. We used to walk hand in hand through the village and be so happy. And I remember our little son who was so cheerful all the time. And we used to just spend our days farming, collecting our produce and nothing ever bad happened. And you know, the drinking, I never thought it was a problem. I always thought I was such nice to time to sit with my friends, to chat. They'd moan about their work, their jobs, their family. I never moaned. I was always happy. But it was only that one day, it was just that one day when they told me something that I was scared about. They told me that they had seen you with this guy. And I was so shocked, I was so confused. They said:

AA42: (Friend's perspective) "Patrick, she's sleeping with someone else. I saw her, her being really, really friendly with this shopkeeper."

MG46: (Man's perspective) I didn't know what to think. What could I do?

AA42: I'm getting, ah. I'm getting really really angry now. I'm just going to go home. I'm really drunk. Oh I mean. Oh, there she is. I've been told today that you've been spotted with another man. Apparently it's the shopkeeper. What do you have to say?

MG46: (Woman's perspective) I was just buying, I was just buying my newspaper. I didn't do anything. What are you talking about?

AA42: (Man's perspective) Of course you would say that, of course.

MG46: (Woman's perspective) No, I wasn't doing anything.

AA42: (Man's perspective) Ah, you did, didn't you? You did, you're lying!

MG46: (Woman's perspective) Of course I didn't!

AA42: (Man's perspective) You're lying! [You're lying]

MG46: (Woman's perspective) [I'm not lying]

AA42/MG46: (Makes combative sounds)

AA42: (Man's perspective) Oh my God. No no no no no, this is just a mistake. Don't take me away! No it's fine, it's fine. She's my wife!

MG46: (Police perspective) You're coming to jail.

AA42: (Man's perspective)She's my [wi-!]

MG46: (Police perspective) [You're] coming to jail.

AA42: (Man's perspective) Ahhhhh, I don't know what I've got myself into. What is going to happen? Am I going to be beaten by the police? What's going to happen? Ah, I'm just going to rot it here, aren't I? Oh, oh, I can't believe she's talking to the police and telling, telling them all this nonsense. I can't believe what she's doing. [Oh..]

MG46: (Woman's persepective) [He hit me.] He hit me in the face. I didn't do anything. He just came out of nowhere and just hit me.

AA42: (Man's perspective) Ah, she's twisting the story, I can't believe this. Ah, I suppose I'll have to sort of just, this is gonna be my life now. I'm just gonna rot in a cell. What would I do to just go go back and redeem myself. I know I can be better, I know I could be a good father.

MG46: I just think that's the only thing I can do. I just have to wait until I get out of here and then I can see my family again. We're gonna be okay, like it was before. It's gonna be good again. (Guards perspective) Here you go, here are your clothes back. (Man's perspective) Ah, Thank you, I can't wait to get out. I'm so happy to see the Sun again. My family! There you are! It's been so long!

AA42: (Commentary) This one.

MG46: Ah yeah, we need that one in a minute. (Man's perspective) But why aren't they excited to see me.

AA42: (Woman's perspective) Ah, he's back again.

MG46: (Man's perspective) Look, just let me sit down and tell you what happened. I just want to, just want to explain to you exactly why this all happened and then we can be, we can be okay again. You know, I'm a changed person. I don't drink anymore. I don't act like that. We can be happy again. Like it was before. And scene.

AA42: Scene.

MJ71/MJ32

MJ32: So we begin with a man who is very happy in his life. He has, you know, a family. He works on a field with his wife and they're all happy together. He has two sons, a small son and an older son and when they come back together he is reminded by somebody who he passed on the way back from the field about the story, about his brother who's in prison. And he starts to begin to tell the story that he uses as a moral compass.

MJ71: So the story of the brother is he tried to live a moral life, an upright life and he tried to stay away from bad influences and said, "No" when his friend tempted him with, you know, drinking midday. Eventually he gave in and he started drinking with them and they, and his friends tried to break his relationship. So his friend told him that this guy's wife flirted with him. He got upset, went back to his wife, asked her if it was correct. She denies it. He beats her up. She is beat up, crying, trying to protect her little baby. He's being carried away by law enforcement. She is giving testimony on what happened and he is sitting there thinking, "Gosh, what did I do with my life? I'm gonna end up languishing my whole life in prison." Indeed, that's what happens sadly. He gets thrown into prison and he has plenty of time to think of what he did.

MJ32: And then, one day, a little bit further on in the future, he comes back home and sees his [family.]

MJ71: [He comes back]. (Commentary) Do you want to say he comes back to the other -

MJ32: Yeah, sorry. We're doing [unclear]

MJ71: [So there's two stories, it's]

AS: [Okay]

MJ71: [All of this was a story that one brother was telling about his brother]

AS: [Mhmm]

MJ71: And now we're going back to the first brother

MJ32: Yeah, and so a little bit on from [the story.]

AS: [Oh, okay.]

MJ32: (Narration) He's going back home and realise, and seeing his family a bit miserable and a bit grumpy about their life. And he's reminded, you know, (man's perspective) think about my brother and [what he's thinking of.]

MJ71: [Yeah so,] (Commentary) So this is me being the other brother now. (Narration) Going back, so, and he, and he is saying: "Look, my brother is

sitting in prison and all he can hope for is this kind of freedom where he comes home and his family greets me. And look, we have this freedom and we're not even happy. And all he's just sitting there and he's just hoping that one day he gets free but it never comes so he's just stuck there. So we should be happy with what we have."

MJ32: And, going back to the original storyline, original timeline. He's, the brother continues to tell his story to his friends, to everybody he's with to kind of keep them on like a moral kind of line, I guess.

MJ71: [Yeah]

MJ32: Kind of remind them, you know, enjoy your freedom and don't do bad things.

Appendix M: Number of biased elements included in each story in all phases of the Family Problems Picture Task

Participant	Phase	Social	Gossip	Survival	Positive Emotional	Negative Emotional	Moral	Counterintuitive	Rational
MF85	1	16	1	4	4	4	7	0	0
	2	17	2	0	4	5	8	0	2
	3	24	1	1	3	4	6	0	0
MF37	1	0	0	0	0	0	0	0	0
	2	17	2	0	4	5	8	0	2
	3	37	1	3	4	11	7	0	1
MG81	1	17	1	0	4	6	4	0	0
	2	23	1	1	2	13	8	0	2
	3	0	0	0	0	0	0	0	0
MG49	1	23	1	2	1	7	3	0	0
	2	23	1	1	2	13	8	0	2
	3	21	3	2	2	7	5	0	0
AA42	1	31	0	1	2	4	9	0	2
	2	16	1	2	5	6	4	0	0
	3	23	2	1	2	7	5	0	0
MG46	1	20	2	2	3	4	2	0	0
	2	16	1	2	5	6	4	0	0
	3	0	0	0	0	0	0	0	0
MG31	1	16	1	3	2	8	6	0	1
	2	16	1	1	0	3	4	0	0

Participant	Phase	Social	Gossip	Survival	Positive Emotional	Negative Emotional	Moral	Counterintuitive	Rational
	3	12	2	2	0	5	5	0	1
MG25	1	32	1	3	2	21	6	0	0
	2	16	1	1	0	3	4	0	0
	3	32	1	2	3	7	5	0	0
MG10	1	30	1	1	1	6	7	0	0
	2	31	1	1	4	9	8	0	0
	3	25	1	1	2	8	7	0	0
AA84	1	14	1	2	1	2	2	0	0
	2	31	1	1	4	9	8	0	0
	3	0	0	0	0	0	0	0	0
MG64	1	14	0	0	0	3	4	0	0
	2	24	1	2	5	8	10	0	1
	3	0	0	0	0	0	0	0	0
MG45	1	13	1	1	0	2	4	0	0
	2	24	1	2	5	8	10	0	1
	3	11	0	1	0	6	8	0	0
MG32	1	30	2	2	3	10	7	0	0
	2	20	1	3	2	9	7	0	1
	3	0	0	0	0	0	0	0	0
MG41	1	9	0	1	1	6	5	0	0
	2	20	1	3	2	9	7	0	1
	3	19	1	2	3	9	6	0	0

Participant	Phase	Social	Gossip	Survival	Positive Emotional	Negative Emotional	Moral	Counterintuitive	Rational
MJ71	1	20	1	4	2	4	5	0	0
	2	21	1	0	3	7	11	0	0
	3	21	1	5	1	5	5	0	0
MJ32	1	17	1	0	2	4	4	0	0
	2	21	1	0	3	7	11	0	0
	3	0	0	0	0	0	0	0	0
MJ21	1	25	1	2	3	13	10	0	0
	2	41	2	3	2	11	11	0	0
	3	14	1	0	0	6	8	0	0
MJ87	1	22	0	0	1	9	7	0	0
	2	41	2	3	2	11	11	0	0
	3	24	2	0	0	8	9	0	0
MK47	1	12	1	4	3	6	4	0	1
	2	35	1	2	2	11	11	0	4
	3	0	0	0	0	0	0	0	0
MK19	1	20	2	0	1	8	5	0	0
	2	35	1	2	2	11	11	0	4
	3	0	0	0	0	0	0	0	0
ML28	1	14	1	2	0	4	4	0	0
	2	27	1	2	2	8	6	0	1
	3	0	0	0	0	0	0	0	0
AA27	1	27	3	3	0	9	3	0	1

Participant	Phase	Social	Gossip	Survival	Positive Emotional	Negative Emotional	Moral	Counterintuitive	Rational
	2	27	1	2	2	8	6	0	1
	3	27	1	2	1	7	4	0	1
ML14	1	21	1	2	0	12	10	0	3
	2	34	1	2	3	13	5	0	2
	3	0	0	0	0	0	0	0	0
ML53	1	27	3	1	0	4	15	0	4
	2	34	1	2	3	13	5	0	2
	3	27	1	2	4	12	5	0	3
MN59	1	13	3	1	0	1	2	0	2
	2	15	1	1	2	4	8	0	1
	3	0	0	0	0	0	0	0	0
MN92	1	21	1	0	4	8	10	0	0
	2	15	1	1	2	4	8	0	1
	3	0	0	0	0	0	0	0	0
MS95	1	17	1	1	4	7	5	0	1
	2	26	2	1	2	11	8	0	1
	3	0	0	0	0	0	0	0	0
MS19	1	31	2	1	7	13	8	0	2
	2	26	2	1	2	11	8	0	1
	3	0	0	0	0	0	0	0	0
MU70	1	25	1	2	1	13	7	0	0
	2	44	2	2	4	11	10	0	0

Participant	Phase	Social	Gossip	Survival	Positive Emotional	Negative Emotional	Moral	Counterintuitive	Rational
	3	0	0	0	0	0	0	0	0
MU43	1	27	1	3	4	4	4	0	3
	2	44	2	2	4	11	10	0	0
	3	0	0	0	0	0	0	0	0
MU77	1	39	1	3	1	8	7	0	1
	2	43	2	1	3	10	13	0	3
	3	0	0	0	0	0	0	0	0
MU97	1	12	2	2	2	0	0	0	0
	2	43	2	1	3	10	13	0	3
	3	19	1	3	0	6	3	0	1

Appendix N: Calculated differences for potential dominance variables between interlocutors for each dyad

Dyad	Difference in time spent speaking as a percentage	Difference in time taken between turns (s)	Difference in overlaps (s)	Difference in interaction with images per second
MF85MF37	12.9675	0.0136	0.8425	0.1210
MG81MG49	33.2821	0.0200	0.9259	0.2205
AA42MG46	18.3920	0.0806	1.1210	0.1367
MG31MG25	2.0066	0.1817	0.6241	0.1447
MG10AA84	26.9035	0.0624	1.0839	0.1775
MG64MG45	4.3763	0.4840	0.8010	0.1200
MG32MG41	10.2839	0.1643	0.7356	0.0278
MK47MK19	8.7987	0.3708	1.0717	0.0234
ML28AA27	6.0723	1.0158	1.8439	0.2903
ML14ML53	5.8703	0.4034	0.9907	0.1300
MN59MN92	25.8439	0.2920	0.8622	0.0634
MS95MS19	15.1100	1.1117	0.9803	0.0267
MU77MU97	12.4791	0.0422	0.7662	0.0769